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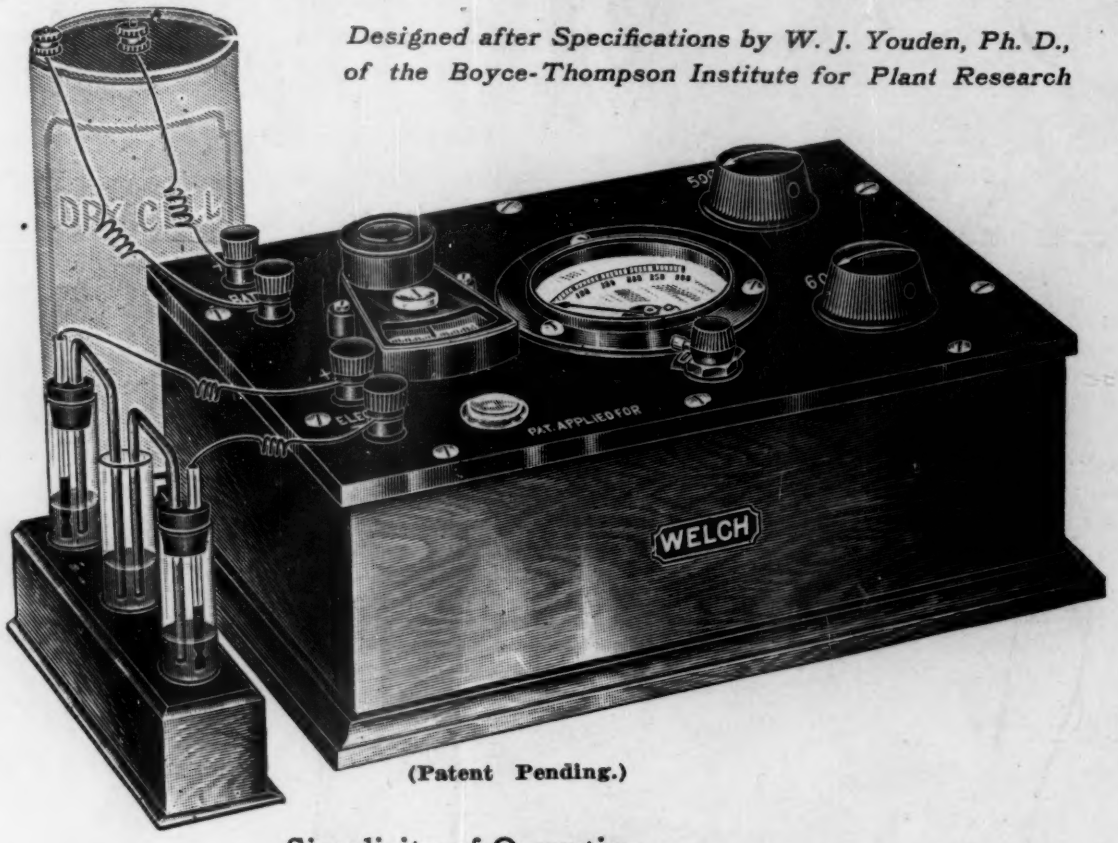

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ZONES OF WEAKNESS IN THE EARTH'S CRUST

By Dr. WILLIAM BOWIE

U. S. COAST AND GEODETIC SURVEY

THE advocates of the theory that the great deformations in the earth's crust have been caused by a cooling of the interior of the earth and the collapse of the crust to fit the reduced area of the surface of the nucleus have, in general, accepted isostasy as a scientific principle. They, however, seem to need zones of weakness within which uplift occurs in order to permit the crust to fit the shrinking nucleus. They also are of the opinion that the Airy idea of isostasy is the true one.

I am writing this paper in order to call attention to the idea that the areas which have been receiving vast amounts of sediments, possibly to depths of five or more miles, should not be the zones of greatest weakness in the earth's crust.

The heavy beds of sediments are laid down, in general, along margins of oceans or inland seas. At least this is the generally expressed opinion of the leading writers of geological literature. It has been shown in "Isostasy"[1] and in a number of publications of the Coast and Geodetic Survey that areas of heavy sedimentation are not out of equilibrium. It is evident, therefore, that the weight of the sediments pushes down the crust beneath. The lower part of the crust necessarily enters subcrustal space and there is a horizontal movement of the displaced subcrustal material in a direction towards the area from which the sediments were derived. The volume of subcrustal material displaced will not be as great as the volume of the sediments. This is because the upper part of the subcrustal material must be of greater density than that of the sediments. Of course, the unconsolidated sediments have very light density, probably not more than 2.4. It may be that the density is 2.2. When these sediments are consolidated, the density will probably rise somewhat over

[1] E. P. Dutton and Co., New York, 1927. Spec. Pubs. 40, 99, and Serial 366, U. S. Coast and Geodetic Survey.

2.5. Let us assume that the average density of the sedimentary material to a depth of 5 miles is 2.6 and that the density of the subcrustal material is 3.1. Then there will have been a thickness of subcrustal material pushed aside of 4.2 miles as a result of the deposition of 5 miles of sediments.

It is probable that the crust underlying the sediments will have been strengthened by an amount equal to the strength of the sedimentary beds or for a time, at least, this would be the case. It is only when the crustal matter which is pushed down into subcrustal space by the weight of the sediments takes on the temperature that is incident to the new zone it occupies that this crustal matter will have the physical characteristics of subcrustal material.

The term residual rigidity is frequently used in discussing earth problems. A material that is said to have residual rigidity is supposed to resist deformation unless the force exerted on it approaches the elastic limit of the material. In this sense the residual rigidity is equivalent to the term strength. A material lacking in this quality is assumed to change form even though the force exerted on it may be very small, provided it acts for a sufficiently long time.

That there is an outer strong shell of the earth seems to be certain. This shell or crust is composed of rock widely varying in density which has residual rigidity and can, therefore, withstand the stress differences incident to great differences in the elevation of contiguous parts of the earth's surface. Under the Himalayas, for instance, we have material that must be approximately 5 per cent. lighter than normal, while, in the Indo-Gangetic plain, a comparatively short distance south of the Himalayas, the crustal density may be assumed to be normal. We, therefore, have a column sixty miles in length under the Indo-Gangetic plain while under the Himalayas the length of the column would be approximately sixty-three miles. The mass of material in each column is the same, therefore throughout the crust there is a stress difference exerted in the direction from the Himalayas towards the plain. If the crustal material had no residual rigidity, there would be a slumping down of the prism of the earth under the Himalayas but this has not occurred in the past nor is it probable that it is occurring now. It would seem, from the above, that the physical characteristics of the crustal material are different from those of the material just below the crust. In the lower material there is practically no residual rigidity. If this were not so, then isostatic equilibrium could not be restored after it had been disturbed by erosion and sedimentation.

It would seem probable that the strength of the crust under the sedimentary zone should have been augmented rather than decreased by the consolidated sedimentary material. This statement is based on the assumption, which may or may not be true, that the increase in the temperature of the crustal material that has entered subcrustal space does not occur immediately upon the subsidence. There must be a lag in time.

If there are any weak zones of the earth's crust it would seem that they underlie the regions which have undergone very great erosion. Take, for instance, the Himalayan mountains. They have an average elevation of between two and three miles. Great masses of material have already been eroded from these mountains and enormous amounts must be eroded in the future prior to the base leveling of their area. If we assume that the average density of the material of the Himalayas from the surface to a depth of about five miles below the surface is 2.8 and that the density of the upper part of the subcrustal material is 3.1, we have a difference in density of 0.3. The difference is approximately 10 per cent.

Since isostatic equilibrium is maintained, or at least nearly so, we should have an upward movement of the crust below of about nine hundred feet when one thousand feet of material had been carried away from the surface. If the average elevation of the Himalayas is only two miles, it would seem that we should have to have approximately twenty miles of erosion before the area had been base leveled. This would mean that about eighteen miles of subcrustal material would have to enter crustal space in order to maintain equilibrium. This amount of erosion may be excessive. If so, it is because the difference between upper crustal density and upper subcrustal density is greater than 10 per cent. If we assume that the difference is 20 per cent., we should then require an erosion equivalent to ten miles of material from the Himalayan mountains to base level the area, if no other processes are involved in base leveling. If ten miles were removed from the Himalayan region, eight miles of subcrustal material would have to rise into crustal space to maintain the isostatic equilibrium.

If no cooling of the subcrustal material, which has entered crustal space, should occur prior to base leveling, then this subcrustal material would have no residual rigidity or strength. The portion of the crust under the base-leveled area would then be only about fifty-two miles thick. This contrasts with sixty-four miles, the thickness of the crust under the area of sedimentation. The added thickness here is due to the beds of new sedimentary material assumed to be five miles thick.

As soon as the subcrustal material which had moved upward had taken on a temperature normal to its new position it should have the characteristics of crustal matter and be able to offer resistance to stress

differences; in other words, the depth of the strong material would then be normal, or sixty miles.

If the buckling of the earth's crust should occur during or just after the end of the base leveling activity, then surely the weak areas would be where the great erosion had taken place and, therefore, we should expect the crust under the erosion areas to bulge up. This would add to the height of the material that may exist above sea-level at the time. It would certainly seem improbable that the crust under the sedimentary, rather than the erosion, area would be pushed up by the contraction of the nucleus and the collapse of the crust.

Professor Gutenberg has estimated that the contraction of the earth, due to loss of heat, is equivalent to the shortening of the circumference of the earth at the rate of one or two centimeters per century. He stated, in a lecture recently given in Washington, D. C., that, in his opinion, the forces due to the contraction are accumulated in the crust till such time as they may be so great as to overcome the strength of crustal material. If, however, there is an accumulation of stresses in the crust rather than a continuous yielding of the crust due to the assumed shrinking of the nucleus, then we should have to postulate that there must be a void existing between the crust and the nucleus. This we may be sure can not be true. It is extremely doubtful that any void can exist in the earth at a depth as great as sixty miles.

It seems to me that the advocates of the contraction hypothesis have assumed that the interior of the earth is losing heat while the crust is maintaining its temperature. This assumption was advanced originally in order to give some rational explanation of the observed horizontal movements of strata. With the proof of isostasy it would seem most improbable that the contraction hypothesis is correct, for there are many points of weakness in it or, at least, there are points of weakness in the explanation of the processes which are involved in the changes of elevation of the earth's surface.

No one will deny that there have been horizontal movements of crustal material, but it would seem that these horizontal movements must be incident to the vertical movements involved in the surface changes.

Let us assume that a block of older strata like that composing Chief Mountain, Montana, has moved horizontally a distance of ten miles over younger strata.[2] This, in my judgment, does not prove that there has been a buckling of the earth's crust. In the first place, the Chief Mountain material has moved from its original position. This means that the base on which it formerly rested did not move with it. The base must have remained fixed. Then, again, since Chief Mountain moved over to a new position and is resting on newer rock, the crust now beneath the mountain must be in its original position for, otherwise, Chief Mountain would not be on it.

It seems probable that the evidence, found in any uplifted area in favor of horizontal movements, indicates that only a few miles of the outer crust are involved. These horizontal movements probably took place at depths less than five miles below the surface. Let us assume that the horizontal movements occurred in material that was only five miles in thickness. If this should be the limit of moving material, then it is rather difficult to see how forces acting through hundreds of thousands of miles of this outer thin layer could result in the buckling up of an area to form mountains from one to three miles in average height. If the outer five miles could have moved horizontally, with no horizontal movements of the remaining 55 miles of the crust, there should have been a piling up of material as extra loads added to the prism of the crust below. Of course, if isostatic adjustment had followed immediately on the piling up, the crust below would have been depressed by an amount proportional to the relation of the density of the surface material and that of the upper part of the subcrustal material. The difference in density of these two materials is probably not more than 10 or 20 per cent. If we assume that it is the latter, then there would have to be an accumulation of material by horizontal movement of the outer layer of fifteen or more miles in thickness in order that a mountain mass three miles high might have been formed. If there has been a mere piling up of material without isostatic balance, then gravity would have been badly disturbed and there would be indications of the presence of such extra loads in the gravimetric survey data for a mountain area. No such disturbance in the gravity surveys has been found for any mountain area.

The late Joseph Barrell in one of his series of papers on "The Strength of the Earth's Crust" made the statement that the uplift of a plateau region is certainly due to vertical movement and not to any buckling of the earth's crust. If the plateau regions are elevated by vertically acting forces, why can not the mountain areas be elevated in the same way?

A matter which has not received the proper attention in geological literature is the great amount of uplift in continental areas, and especially in plateau and mountain areas, that has been necessary to maintain the isostatic equilibrium as material is carried away by erosion. It has been shown in the early part of this paper that, to base level an area, it is necessary that more material be eroded from an ele-

[2] See p. 230, "Our Mobile Earth," R. A. Daly, 1926.

vated area than was originally present above sea-level in it. Of course, as soon as any area appears above tidal water erosion begins so that there is no such thing as having a mass uplifted to a given height in the mountain-building process without any erosion having occurred in that time. But let us assume that there has been an uplift of two miles on the average. Then, during the erosion, there will have been an upward movement of the crust below to restore the balance of from five to ten miles, perhaps more, before base leveling will have been accomplished. This upward movement occurs in a most irregular manner, in time and in place. The movements would necessarily be along lines of least resistance. These would be vertical in some cases while they would be inclined in others and again near the surface the moving material would at times follow a direction that is practically horizontal. These movements, tending to maintain the isostatic equilibrium, would cause much distortion, fracturing and tilting of strata. It is believed that much of this distortion, due to the maintenance of the isostatic equilibrium, has been erroneously attributed to horizontal movements of crustal material at the time the area was originally uplifted.

If there are zones of weakness in the earth's crust needed for the formation of mountain systems, I should advocate that the zones be placed where there has previously been great erosion, but having the zones in those locations does not fit into the plan of having the mountain systems formed where just previously there had been very heavy sedimentation. It would really appear as if there are no zones of weakness in the sense required by the advocates of the contraction hypothesis. It would seem, therefore, that the causes which change the configuration of the earth's surface are quite local. What affects one area to cause the uplift of a mountain or plateau has nothing to do, in my judgment, with the uplifting of the earth's surface at some other place far removed.

PERIODICALS FOR MATHEMATICIANS

By Professor EDWARD S. ALLEN

IOWA STATE COLLEGE

IN 1927 there was published in SCIENCE[1] the result of an investigation of the references, in the volume of the *Journal* of the American Chemical Society for 1926, to other periodicals. This year a number of colleagues have cooperated with me in making a similar study in the field of mathematics. It is unnecessary to repeat what was said in the former article about the importance of an adequate department library even in a small institution, and about the value of such studies in helping librarians to choose the most useful periodicals.

We decided, at the outset, that it would be unfair to base any judgment on work quoted in one mathematical journal alone. The *Transactions* of the American Mathematical Society most nearly correspond to the *Journal* of the American Chemical Society, yet the number of citations and the range of subjects treated in any one year are an inadequate basis for reliable conclusions. We therefore at once took into consideration the volumes of the *Annals of Mathematics* and of the *American Journal of Mathematics* for 1928. Then, feeling that even these three would be unrepresentative of the needs of working mathematicians, we added the 1928 issues of six of the seven foreign journals which they most frequently mentioned. Crelle's *Journal* would also have been included but for the decision to restrict the representation of each European nation to one periodical. The following table gives the journals used and the number of references taken from each.

TABLE I

		No. of references
Trans. Am. Math. Soc.	vol. 30	249
Annals of Math.	vol. 29, no. 2–4	
	vol. 30, no. 1	309
Amer. Journ. of Math.	vol. 50	211
Proc. London Math. Soc.	vol. 27, parts 5, 6, 7	
	vol. 28	252
	vol. 29, part 1	
Math. Annalen	vol. 99, 100	454
Journ. de Math. (Liouville)	vol. 7	110
Rend. Circ. Mat. Palermo	vol. 52	151
Acta Math.	vol. 51, no. 3–4	
	vol. 52, no. 1–2	65
Fund. Math.	vol. 11, 12	364
Total		2,165

Of these nine journals, three are American, three predominantly British, German and French, respectively, and three international.

Thus, it will be seen, we have information with something of an American bias, yet probably no more than there should be in a list intended primarily to be helpful to American librarians.

[1] P. L. K. Gross and E. M. Gross, "College Libraries and Chemical Education," SCIENCE, 66: 385, 1927.

For each citation there were noted the periodical in which the reference was found, that to which it referred, the year of publication of the latter and the language of the article cited. No count was taken of references to the encyclopedias, the Cambridge Tracts, the Mémorial, reports of congresses and similar series published at irregular intervals; certainly libraries should own as nearly complete sets of these as possible. Neither do the tables which follow take note of the five citations of articles over a hundred years old, for libraries could not, in general, hope to possess such collections as *Acta Eruditorum*.

The following table gives the total number of references to the thirty journals which were mentioned as many as fifteen times, distributed according to the last two decades and the preceding eighty years.

TABLE II

	1829–1908	1909–18	1919–	Total
Math. Annalen	75	51	124	250
Fund. Math.			201	201
Trans. Am. Math. Soc.	18	31	82	131
Proc. Lond. Math. Soc.	30	27	59	116
Comptes Rendus	31	24	56	111
Math. Zeitschrift			79	79
Bull. Am. Math. Soc.	11	9	58	78
Acta Math.	22	10	37	69
Journ. f. Math. (Crelle)	42	11	10	63
Annals of Math.	8	12	42	62
Am. Journ. of Math.	11	14	33	58
Proc. Nat. Acad.		4	53	57
Rend. Circ. Mat. Palermo	14	23	10	47
Rend. Accad. Lincei (*sci. fis.*)	8	11	23	42
Proc. Amst. (and Verslag)	2	14	24	40
Ann. sci. école normale	13	3	22	38
Journ. d. math. (Liouville)	19	9	5	33
Bull. d. scien. math. (Darboux)	5	2	24	31
Gött. Nach.	8	8	13	29
Bull. Soc. Math. France	17	3	9	29
Annali di mat.	24		2	26
Quart. Journ.	15	5	4	24
Jahresbericht, D. M. V.	7		15	22
Monatshefte Math. Phys.	2	4	14	20
Vienna Sitzung. (IIa)	6	7	7	20
Phil. Trans. Roy. Soc. (A)	15	2	2	19
Proc. Roy. Soc. (A)	8	3	7	18
Phil. Mag.	7	2	7	16
Journ. Lond. Math. Soc.			15	15
Mess. of Math.	2	5	8	15

We considered what would be the effect of rejecting references in one article to another article in the same journal. This was suggested by the procedure in the case of the chemical survey; it would counteract the tendency, very marked in some journals, to refer to previous articles in the same series so much as to misrepresent the needs of the general worker. However, these self-references had a strong influence on the ranks of only two periodicals—the *Proceedings* of the London Mathematical Society and *Fundamenta Mathematicae*. And even there the modified record still shows them to be among the most desirable serials; and, furthermore, their relative rank is scarcely disturbed at all if we merely reject an author's reference to his own previous work—perhaps a more reasonable method.

We also made a study of the relative ranks of periodicals when references in American journals alone were considered. Perhaps the most important alterations of standing are the lowering of the place of the *Mathematische Zeitschrift* and the advance in rank of *Biometrika* and the *American Mathematical Monthly* (which did not even gain a place in Table II). On the whole, it does not seem worth while to reproduce the results of this particular study. For one thing the data are less extensive. And if there were any one-sidedness, any excessive inbreeding in American mathematics, the use of American references only as a guide for librarians would merely tend to perpetuate them.

The following table shows the total number of periodicals cited, with the distribution of those not named in Table II according to the number of citations.

TABLE III

Periodicals included in Table II	30
" cited 10–14 times	14
" " 5– 9 "	21
" " 4 "	8
" " 3 "	10
" " 2 "	19
" " 1 time	36
Total	138

It would be convenient to be able to infer, in a mechanical way, that Table II gives an adequate guide for a librarian. Thus, one can by its use distinguish between those journals whose large (and expensive) series of volumes contain a moderate number of useful articles apiece, and those of recent origin which have at once published a number of important works; that is, between those whose files are desirable and those for which a current subscription is important. Conspicuous examples of the latter type are *Fundamenta Mathematicae, Mathematische Zeitschrift* and, of even more recent origin, the *Journal* of the London Mathematical Society.

Yet it would be decidedly unwise to use the results

of our tabulation uncritically. For instance, the *Proceedings* of the London Mathematical Society and *Fundamenta Mathematicae* have nearly the same rank, whatever criterion is employed. Yet a knowledge of the two journals will tell that the one is more important for a general mathematical library, the other in a department which specializes in questions of the bases of mathematics or in the theory of aggregates. Again, the mere listing of the number of references takes no account of the amount of material covered by one citation. One article in *Acta Mathematica* has many times the length, and in general many times the importance, of one in *Comptes Rendus*. An indication that these statistics may be misleading in the lower ranges is the fact that the *Sitzungsberichte* of Berlin were cited only half as many times as those of Vienna, and were therefore not included in any of our tables. It is probably fair to assume that this difference is due to the accident of the interests of mathematicians publishing in 1928.

In spite of these limitations, libraries may well be definitely helped by this investigation. Of the first thirteen serials of Table II, all except two are strictly mathematical journals, and should, in view of their importance, be on the subscription list of all mathematical libraries. To these the most important additions, in my opinion, are Liouville's *Journal, Annali di Matematica* and *Annales de l'école normale,* all of which publish memoirs of fundamental importance. American libraries will of course have the *American Mathematical Monthly,* while *Biometrika* is needed by workers in biological statistics.

Libraries should, as far as possible, have files of the American research journals and, among the longer established European periodicals, should do their best to obtain the *Annalen,* the London *Proceedings* (at least the volumes since 1890), *Acta,* Crelle's and Liouville's *Journals.*

Since the demand for non-specialized scientific serials is distributed among many departments every college library which wishes to further scientific progress should attempt to have all such periodicals listed in Table II. As has been suggested before, the Berlin *Sitzungsberichte* should certainly be added to the list. After the publications of the Paris and London academies, those from Berlin are the ones whose files are most desirable. The prominence already attained by the *Proceedings* of the National Academy deserves especial mention.

As to the languages which the mathematical worker should have at his command, the usual four are, of course, well in the lead.

TABLE IV
LANGUAGES USED IN ARTICLES CITED

	References in All journals	References in American journals
English	779	428
German	639	151
French	568	127
Italian	161	50

The high rank of English is obviously due in part to the fact that that language is almost exclusively used in four of the nine journals from which data were taken. It should be pointed out that a large number of the French citations refer to *Comptes Rendus* and *Fundamenta,* where the average number of pages in an article is small. The figures of our table, therefore, give too low an estimate of the relative importance of German and Italian.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

GENERAL LECTURES FOR THE DES MOINES MEETING

THE annual meetings of the American Association and associated organizations are now generally attended by several thousand science workers representing a large number of different fields of science, and the cities in which these meetings are held are so selected as to carry the advantages and the influence of the meetings successively into different regions of the eastern United States and Canada. Most of the thousand or more papers and addresses presented are technical in character, given by men and women of science for other workers in their respective fields, but the association aims to have on the program for each meeting a number of non-technical, semipopular or popular lectures on a variety of scientific subjects. These are given by eminent authorities in their own fields, but they are presented in such style as to be interesting to science workers in other fields and to the intelligent public generally. In some instances illustrated lectures are specially arranged for students in the schools of the city in which the meeting is held. All these general lectures are freely open to everybody and they are widely reported in the daily press throughout the United States and Canada and beyond. Recent results of research and recent trends of thought in the special sciences are thus made available to workers in all branches, and science as a whole

is measurably advanced. Scientific knowledge and increased appreciation of what science is doing are brought to the public. The interest of the youth of the community in well-grounded scientific knowledge and in the scientific method of thought is appreciably enhanced.

The general lectures that are to be given at the approaching Des Moines meeting of the association are more numerous than for any earlier meeting, with a very wide range of topics and many degrees of non-technicality. They are grouped in two series, those to be given at general sessions of the association and those to be presented as complimentary to the public of Des Moines and vicinity. Some of the general-session lectures will be relatively somewhat less popular, while some of the non-technical lectures have been planned specially for the pupils of the Des Moines schools. Nearly all are to be illustrated by means of lantern slides or motion pictures or both. A list of these general lectures is given below; those designated by asterisks are for general sessions, while those marked with crosses are planned specially for school students. The meeting is to open officially Friday evening, December 27, and it will continue through Thursday, January 2.

*"The Discovery of Tertiary Man," by Henry Fairfield Osborn, of the American Museum of Natural History, retiring president of the American Association. *Friday evening.*

"Where Iowa Gets Her Weather," by Charles F. Brooks, of Clark University. *Saturday at 2:30.*

*"An Anthropologist's View of Race," by Fay-Cooper Cole, of the University of Chicago. *Saturday at 4:30.*

*"Some Aspects of Human Biology," the eighth annual Sigma Xi lecture (arranged by the Society of the Sigma Xi), by George H. Parker, of Harvard University. *Saturday evening.*

"Exploration for Human Origins and Migration in the Far Northwest," by Aleš Hrdlička, of the U. S. National Museum. *Saturday evening.*

"The Alleged Sins of Science," by Robert A. Millikan, of the California Institute of Technology, president of the American Association. *Saturday afternoon.*

†"Collecting Live Animals in Africa," by William M. Mann, of the U. S. National Zoological Park. *Monday at 2:30; repeated Tuesday at 2:30.*

"Our Ocean of Air: What It Is and Where It Comes from," by W. J. Humphreys, of the U. S. Weather Bureau. *Monday at 2:30.*

*"Earthquakes and What They Tell Us," by James B. Macelwane, S. J., of St. Louis University. *Monday at 4:30.*

*"The Relation between the Size of the Energy Atom and its Physiological Effect," by W. T. Bovie, of Northwestern University Medical School. *Monday evening.*

"The Adler Planetarium and Astronomical Museum of Chicago," by Philip Fox, of the Adler Planetarium and Astronomical Museum. *Monday evening.*

*A Symposium on the Salary Question, arranged by the Committee on the Economic Status of Research Workers, of the Committee of One Hundred on Scientific Research (Robert A. Millikan, president of the American Association, *chairman;* Rodney H. True, of the University of Pennsylvania, *secretary*). *Tuesday afternoon.*

†"By Airplane to Pigmy Land (Dutch New Guinea)," by M. W. Stirling, of the Bureau of American Ethnology. *Tuesday at 2:30.*

*"The Application of Mathematics in the Social Sciences," the seventh annual Josiah Willard Gibbs lecture (arranged by the American Mathematical Society), by Irving Fisher, of Yale University. *Tuesday at 4:30.*

"The Living Wealth of Alaskan Waters," by Louis Radcliffe, deputy commissioner of fisheries, U. S. Department of Commerce. *Tuesday at 4:30.*

*"Glaciation: the Background of the Development of the Mississippi Valley," by George F. Kay, of the University of Iowa. *Tuesday evening.*

†"Turning the Clock Back Ten Million Years," by Arthur S. Coggeshall, of St. Paul Institute, St. Paul, Minnesota. *Wednesday at 2:30.*

*"Some Aspects of Celestial Evolution," by Edwin B. Frost, of the Yerkes Observatory. *Wednesday at 4:30.*

*"The Laws of Racing Fatigue—Men and Horses," by A. E. Kennelly, of Harvard University. *Wednesday evening.*

†"Clouds of Everywhere and their Splendors," by W. J. Humphreys, of the U. S. Weather Bureau. *Thursday at 2:30.*

This lecture series has been worked out from suggestions made by the executive committee of the association and by the special committee on general lectures (D. W. Morehouse, Austin H. Clark and Henry B. Ward).

BURTON E. LIVINGSTON,
Permanent Secretary

NOTICES AND REPORTS FOR 1929, INCLUDING PREPARATIONS FOR THE DES MOINES MEETING

MANY readers of SCIENCE who are planning to attend the approaching Des Moines meeting, from Friday, December 27, 1929, to Thursday, January 2, 1930, and many who are not going to the meeting may find it useful to have brought together here the following references to articles and notices concerning the meeting and the association which have been published in this journal from time to time in the year just closing. Dates of issues and page references are given.

Officers of the American Association for the Advancement of Science. January 4, 1929, pages 10–11.

Note on award of American Association prize to Dr. Oliver Kamm. January 11, 1929, page 35.

General reports of fifth New York meeting. January 25, 1929, pages 79–106.

Accounts of the sessions of sections and societies at the fifth New York meeting. February 1, 1929, pages 107–131.

American Association press service. February 22, 1929, pages 219–220.

Note announcing spring meeting of executive committee. March 29, 1929, page 349.

Note on thirteenth annual meeting of Pacific Division. April 5, 1929, page 375.

Resolution on professional salaries passed at tenth annual meeting of Southwestern Division. May 17, 1929, page 515.

Note on prize awarded by Pacific Division at its thirteenth annual meeting. May 31, 1929, page 572.

Report of spring meeting of executive committee. May 31, 1929, pages 582–584.

Reports of the second Berkeley meeting of the Pacific Division. August 9, 1929, pages 129–133; August 16, 1929, pages 154–159.

Announcement of Des Moines sessions of Section F and American Society of Zoologists. August 23, 1929, pages 186–187.

Note announcing fall meeting of executive committee. September 20, 1929, page 279.

Note on seventh Josiah Willard Gibbs lecture at Des Moines. October 18, 1929, page 375.

The Michael P. Rich bequest for the advancement of science. October 25, 1929, pages 396–397.

Applications for grants for 1930. October 25, 1929, pages 397–398.

The section on geology and geography at Des Moines. October 25, 1929, page 398.

Section I (Psychology) at Des Moines. October 25, 1929, page 398.

The new volume of Summarized Proceedings. November 1, 1929, page 419.

Hotels for the Des Moines meeting. November 1, 1929, pages 419–420.

Report of the fall meeting of the executive committee. November 8, 1929, pages 442–443.

The present enrolment. November 15, 1929, pages 470–471.

Preliminary announcement of the Des Moines meeting. November 29, 1929, pages 511–530.

The Des Moines prize. December 6, 1929, pages 546–547.

Life membership in the American Association. December 13, 1929, pages 568–570.

General lectures for the Des Moines meeting. December 20, 1929, pages 594–595.

The citations given above constitute all the officially published material concerning the American Association and its work for the calendar year 1929, excepting what is contained in the volume of Summarized Proceedings of the American Association for the Advancement of Science for 1925 to 1929, which appeared October 15, 1929. That volume is obtainable from the permanent secretary's office, in the Smithsonian Institution Building, Washington, D. C., and it contains references for the period from June, 1925, to June, 1929.

Many addresses and papers given at the Des Moines meeting are to appear in forthcoming issues of SCIENCE, from the issue for January 3 onward. The general reports of the meeting are to appear about February 1 and they will probably occupy most of the pages of two issues of the journal.

BURTON E. LIVINGSTON,
Permanent Secretary

OBITUARY

HARRY TAYLOR MARSHALL

NEAR the center of the campus there stands a small plain brick structure, the original Medical Building of the University of Virginia. Here for almost a century medicine was taught, at first the complete curriculum, during later decades only several branches. Here I first met Harry Taylor Marshall in the autumn of 1908 when he came to assume the duties of the Walter Reed professorship of pathology and bacteriology in succession to Dr. Charles H. Bunting, who had been called to the Medical School of the University of Wisconsin. Here over a long period of years I saw Dr. Marshall almost daily. Pathology and bacteriology occupied the basement and second floor; the first floor gave accommodations for histology and embryology. Under the conditions of such intimate association for so long a period only deep friendship, complete estrangement or a working basis of tolerance could develop. Dr. Marshall quickly drew respect and affection from all his associates, and such was our relationship for twenty years. It seems the refinement of cruel fate that after laboring for so many years under the serious handicaps of inadequate quarters and a meager equipment, he should have had to die when his long-cherished hopes and plans for a modern fully equipped laboratory in a new medical building had just been realized. He had moved into his new quarters, but he had not been able to assume his teaching work. His new student laboratory, suite of offices, technical rooms, media rooms and autopsy rooms had been planned with the greatest care. The combination represents a layout for the teaching of

pathology and bacteriology probably unsurpassed for working efficiency; it will long be a monument to the painstaking devotion and well-organized experience of Dr. Marshall. It is perhaps more true of a pathologist than of any other teacher of the medical sciences that, other things equal, the older the man, within reasonable limits, the more useful he becomes. Dr. Marshall was only fifty-four years of age, and his passing robs our medical school of an outstanding character, a skilful and kindly teacher and a devoted scientist.

Dr. Marshall had been in poor health for a year, and with his family he left this country early in September for Belgium, on a year's leave of absence from the university, in the hope of securing restoration of strength after an extended period of rest. He had apparently already made considerable gain when an acute intestinal disorder necessitated an operation on November 1 which was rapidly followed by embolism. He died of pneumonia on November 8 in the American Hospital in Paris, and was buried in Brussels on Wednesday the thirteenth from the Christian Church in Rue Crespel. He met death, we may be certain, as he met the daily tasks of life, with serenity and confidence. For twenty years he contributed wholeheartedly of his strength, wisdom and skill to the best interests of the medical school and the university. His students and colleagues feel a sharp pang of regret that he should have been denied the satisfaction of continuing his work under the more favorable conditions in the new medical building for which he had so patiently waited.

Dr. Marshall was born in Baltimore, Maryland, on May 19, 1875. He entered the Johns Hopkins University at the age of sixteen and secured the A.B. degree in 1894 and the M.D. degree four years later. Following graduation from the medical school he served for one year as an interne in the Johns Hopkins Hospital. In 1900 he began his career of teacher and investigator, first as a fellow in pathology at Johns Hopkins, then for three years as assistant in pathology, and from 1903 to 1906 as instructor in medicine and pediatrics. The year 1901–02 he spent as a student with Ehrlich in Frankfort, on a traveling fellowship from the Rockefeller Institute. During the summers of 1903 and 1904 he worked in Montana, studying the loco-weed disease of cattle. In 1906 he accepted a call as professor of pathology in the medical school at Manila, Philippine Islands. He served also as pathologist to the Bureau of Science, and for one year as secretary and registrar of the medical school. He returned to the United States in the summer of 1908 to accept the professorship in the University of Virginia. He served on the Virginia Tuberculosis Commission during 1915–16 and on the Virginia State Board of Health from 1916 to 1924. From 1916 to 1918 he was a director of the Virginia Tuberculosis Association. He held the presidency of the Association of Pathologists and Bacteriologists in 1922, and the chairmanship of the section on pathology of the Southern Medical Association in 1928 and the secretaryship in 1929.

When one reflects on the all too brief life of our colleague, one can not avoid a query concerning the reason for the modest list of technical publications from one so well-prepared to advance scientific knowledge. No single word can probably ever fully explain a man or his motives, but the word unselfishness comes very close to doing this in the case of Dr. Marshall. However admirable he may be as a man, the productive scientist must be essentially selfish as regards response to the varied legitimate appeals of modern social life. It is not a question of relative merit or usefulness, but of a difference of temperament and aim. Dr. Marshall gave himself unsparingly to every cause that seemed to him worthy: general student welfare, movements for improving and safeguarding the public health, administrative affairs in his university and various scientific societies, suggesting and directing student research, revision of the medical curriculum, general local culture and the active support of his church. His sparkling thoughtful paper on "The Medical Curriculum" in the *Southern Medical Journal* of December, 1928, in which he outlined a closely coordinated system of medical instruction is a model of a keenly reasoned argument based upon a large body of well-considered data and has not yet received the attention it would seem to deserve. The preparation of this paper required an enormous amount of arduous labor and demonstrates completely the thoroughness and devotion with which Dr. Marshall applied himself to everything he undertook.

He was unfailingly kind and sympathetic. His genial personality, his optimistic philosophy, his gentle humor, his emotional poise, his inimitable courtesy and his perennial willingness to be helpful and generous have left a beneficent impress upon all who knew him. He was a great admirer of Pasteur and of Osler. The latter was among his teachers. One seems to recognize much of the incomparable Osler reflected in the life of Dr. Marshall. One may well believe that he had early adopted the cult of Pasteur, frequently recommended to his students, the worship of great men. Aside from a splendid racial and cultural heritage, adherence to this cult may explain much in the life of Dr. Marshall. It is a suggestion that I feel he would like to transmit as a legacy to all medical students.

H. E. JORDAN

LOUIS CAPITAN

LOUIS CAPITAN, for twenty-one years the Loubat professor of American archeology at the Collège de France, died in Paris on September 1. Dr. Capitan, who sometimes wrote his name Joseph-Louis, was born, also in Paris, on April 19, 1854. His career was remarkable in that although he held a medical diploma, was a member of the Academy of Medicine and an officer of the Legion of Honor with military title for war service, he occupied himself from early youth largely with problems of prehistory, including those of the two Americas. In 1910 he visited Mexico and the United States, and he was one of the few Europeans who continued to write affirmatively about Paleolithic man in America.

According to his own statement, Capitan began his public career as archeologist by exhibiting his collections at the Paris Exposition of 1878. He remained an indefatigable collector almost to the end, and was consequently the possessor of a really considerable amount of material, mostly of French origin but including typical data for nearly all parts of the explored world. The bulk of these collections, it should be added, has been left as a legacy to the French National Museum at St. Germain, where a hall is especially reserved for its display.

As a field investigator Capitan took a leading part, from 1893 onward, with his pupils Breuil, Peyrony and others, in the investigation of the French caverns. Among other things he helped to institute the stratigraphic method of débris excavation and a similarly refined technique for deciphering and copying the remarkable engravings and paintings preserved on the cave walls. As a result, we may assume, he was later elected a really functioning member of several different scientific organizations, as well as of a number of civic commissions for the preservation of monuments, historic and prehistoric, holding various offices in both groups, including that of president. In 1922, when the writer last saw him, Capitan was still acting for the Paris Municipal Committee in charge of studying the antiquities recovered from the subsoil of the old city. In this way he came to have much to do with the conservation of French antiquities and with bringing many of them under permanent state control.

As a teacher Capitan was equally active. In 1899 he succeeded Gabriel de Mortillet in the chair of prehistoric anthropology at the Ecole d'Anthropologie. Later, in 1908, he was also made Loubat professor of American archeology at the Collège de France. This last phase of his work, while he obviously took considerable interest in it, probably gave him the least satisfaction, for he can scarcely be said to have enjoyed first-hand contact with the field. The truth undoubtedly was that Capitan was too old when his American opportunity came.

Concerning Capitan's literary output none but his pupils or intimate colleagues can tell. A man so conspicuously active can scarcely have had much time—even if he possessed the inclination—for protracted writing on any given subject. There is available a nearly complete bibliography of about 150 titles, but of these at least 110 appear to be merely brief summaries (often with illustrations) mainly of lecture and seminar topics. In addition, there are also his recent small handbook, "La Préhistoire," in the Payot series, and about twenty-five original articles (including prefaces and biographical notes) which appeared for the most part in the *Revue Anthropologique*. Finally, Capitan collaborated on about ten original articles and three books, two of which are the Combarelles and Font-de-Gaume Memoirs of the famous series issued by the great patron of prehistoric studies, the Prince of Monaco. A hasty analysis of the titles gives the following: general treatises, eight; topical essays, thirty-seven; European (mainly French) items, thirty; African items, five; North American (chiefly Maya and Mexican) items, forty-one; South American (mostly Peruvian), twenty-four; the Americas in general, four or more, and the Pacific Islands, one. The writings pertaining to the Old World relate, as would be expected, mainly to the Paleolithic arts and industries, while the American papers deal with both Paleolithic and Neolithic topics and touch on almost every imaginable phase of archeology, but seemingly never in any exhaustive fashion.

No superficial survey, such as this, justifies more than a provisional estimate of the worth of Capitan's labors. In any case, judgment on his Old World studies, the fruit of his best years, must be left to Europeans. When we come to consider his contribution as an Americanist, the most that can be said is that he has written clearly and suggestively on a great variety of topics, but as a rule only in a detached and fragmentary way. Even so, the results are valuable, and they are perhaps all that could be expected of the first Frenchman to give his attention to so wide a field.

Capitan wrote vigorously almost to the last, and he lectured until past seventy. Little more than a year ago, on the occasion of the Americanist Congress in New York, he sent another brief article on one of his favored themes, this time entitled "Recent Ideas on the Peopling of America." Whatever we may choose to think of these last efforts to stir our interest, or of his recent second change of mind with respect to European eoliths, in his day he performed valiant ser-

vice. It was the author's privilege to hear him lecture as late as 1922, as well as to travel and work with him for a number of weeks in Belgium, Holland and England. With Capitan may be said to have passed the last of the distinguished group of men who first made us properly acquainted with the physique and culture of Paleolithic man.

N. C. NELSON
AMERICAN MUSEUM OF NATURAL HISTORY,
NOVEMBER 15, 1929

ALEXANDER VASILIEVITCH VASILIEV

(JULY 2, 1853–OCTOBER 6, 1929)

IN the passing of A. V. Vasiliev in Moscow, Russia, the world has lost one of its great scientists, great teachers, great men.

To be a great scientist is one thing; to be a great scientist and a great teacher is quite another. A great teacher must ingest, digest and evaluate the works of others in many lines in order to give broad, judicial and interesting selections to students. To be at once a great scientist, a great teacher and a great man is still different—it is all too rare a combination. Besides the requisites for the first two, individual synthesis, a broad human vision and interest, effective and energetic enough to be an inspiration and guide for living and acting, are essential.

A unique combination of these characteristics made the life of Vasiliev a memorable and most useful one. Not satisfied with his own achievements, he devoted much of his energies to foster, elucidate, coordinate and apply the great works of Lobachevski, Tschebytschev, Weierstrass, Kronecker, Hermite, Sophus Lie, Peano, Whitehead, Russell, Keyser, Einstein, Minkowski and others, and just before his end, the works of De Broglie, Schrödinger and Heisenberg.

Vasiliev was born in the city of Kazan, made famous by Lobachevski. His background was scientific, his father being a noted Sinologue, his grandfather a well-known astronomer and rector of the University of Kazan.

In 1874 he graduated from the University of Petrograd with a gold medal and lectured at the University of Kazan on the theory of function, the theory of numbers and the theory of probability. He was sent abroad in 1879 to prepare for a professorship. In Berlin he studied under Kronecker and Weierstrass, and in Paris under Hermite. In 1884 he was awarded the title of doctor of pure mathematics for his work on the theory of roots of algebraic equations. He became professor emeritus in 1899, and until 1907 he lectured at the University of Kazan. During this period, among other activities he organized the Physicomathematical Circle, was instrumental in the establishment by the Physicomathematical Society of the Lobachevski international prize and initiated the building of a monument to Lobachevski.

In 1907 he was transferred to Leningrad, where he lectured at the university and other institutions of higher learning on the theory of groups, being the first in Russia to emphasize its importance, the theory of numbers, applied mathematics, mathematical philosophy, foundations of mathematics, etc.

In 1923 Vasiliev moved to Moscow and became an active member in the editorial commission of the Mathematical Institute for the full edition of the works of N. I. Lobachevski. He prepared also a biography for the first volume.

His lectures were always brilliant, broad and synthetic, full of freshness and new ideas. An accomplished linguist, at home in Russian, French, German, English, Italian, he read very widely and introduced to his Russian audiences the latest points of view and methods in science. His exceptional erudition outside of mathematics and physics included biology, psychology, history and philosophy, allowing him to make his lectures not only intensely interesting but also simple. His auditoriums were always packed. He approached his students as an equal and inspired them to independent creative thinking. He was to them an ideal of what a scientific man ought to be.

In the international field his influence was also far reaching. He was active with the late Cantor in the organization of mathematical congresses. In his papers and lectures he made Europe acquainted with the works of Russian mathematicians like Lobachevski and Tschebytschev. The Lobachevski International Prizes for works on non-Euclidean geometry and mechanics, in establishing which he was instrumental, have been awarded to men like Hilbert, Sophus Lie; Klein, Poincaré; Coolidge, Whitehead, etc. His international influence was so pronounced that the French scientists induced the French government to award Vasiliev the title of "Officier de l'instruction publique."

Outside of technical papers he was the author of several fine text-books on the theory of function, the theory of numbers, the theory of probability, etc. His beautiful lecture on Lobachevski has been translated into English, German, French, Spanish and Bohemian. Always keeping abreast of his time, he wrote an excellent historical introduction to the Einstein general theory under the title of "Space Time Motion," with an introduction by Bertrand Russell. His broad paper on "The Acquisitions and Enigmas of the Philosophy of Nature," sent to the International Philosophical Congress at Harvard (1926), has been published in book form. A few hours before his death he was working at a historical and methodological introduction to the new quantum mechanics.

In public life Vasiliev was an active member of the left wing of the liberal party; he was elected to the Russian Duma and later was elected by the Academic Union to the State Council.

In such a brief note it is impossible to do justice to the grandeur of such a fruitful life. The present writer will always remember with admiration the interest the late Vasiliev displayed in the application of scientific methods to the affairs of man.

In his scientific works, in the influence which resulted from his broad social consciousness and in the memories of those who were fortunate enough to have been associated with him, he has built for himself a lasting memorial.[1]

Alfred Korzybski

New York

RECENT DEATHS

Dr. Edward Drake Roe, Jr., for twenty-nine years professor of mathematics at Syracuse University, died on December 11, in his seventy-first year.

Professor Fred Neher, of the department of chemistry at Princeton University, a member of the faculty since 1891, died on December 11. He was sixty-two years old.

Professor Ole Olfusen, sixty-four years old, Danish explorer, died at Copenhagen on December 13. Among his works was a book on the Yellowstone National Park.

MEMORIALS

Special memorial services to honor Dr. Victor C. Vaughan were conducted under the auspices of the University of Michigan on December 3. President Alexander G. Ruthven represented the university and Dr. Walter H. Sawyer the regents. There was a representative of the state of Michigan among the speakers also. Dr. Novy appeared for the faculty of the School of Medicine and Professor Moses Gomberg on behalf of the department of chemistry. Professor William H. Hobbs spoke as a colleague of Dr. Vaughan.

Upton House, the Queen Anne mansion in which Joseph Lister was born in 1827, was in 1885 acquired for a vicarage for the Church of St. Peter, Upton Cross, London. In order to repair and preserve the house, an appeal is made for £1,800 by the Parochial Church Council. Checks should be drawn in favor of "Lord Lister's Birthplace Preservation Fund," and sent to the honorary treasurers of the fund at Upton House, Forest Gate, London.

SCIENTIFIC EVENTS

ASTRONOMY IN SOUTH AFRICA

It is reported by *Science Service* that three groups of European astronomers are planning separate observatories in South Africa, in addition to the six already there. The University of Leyden, Holland, will be the next northern observatory to establish a branch south of the Equator to observe parts of the sky invisible from Europe or America. Professor W. de Sitter, director of the Leyden Observatory, has recently inspected South African sites, and decided to establish the branch on the grounds of the Union Observatory at Johannesburg.

Another southern observatory is to be established here as a joint enterprise of all the German observatories. Professor P. Guthnick, director of the Berlin University Observatory at Neubabelsberg, a suburb of Berlin, also made a recent inspection of possible sites. So far he has not decided between Bloemfontein, Pretoria and Windhoek, but it is believed that the odds are in favor of the first.

Further, it is planned to move the Radcliffe Observatory, now at Oxford, England, to South Africa. This institution, equipped with an 18-inch refracting telescope in addition to smaller instruments, has no connection with the University of Oxford, which has its own observatory. Sir Frank Dyson, astronomer royal, and Dr. H. Knox-Shaw, in charge of the Radcliffe Observatory, recently visited possible locations. So far they have not decided between Bloemfontein and Pretoria.

The Royal Observatory at Cape Town is the oldest of the present South African observatories. Its largest telescope is a refractor with a lens 24 inches in diameter. The University of South Africa, also in this city, boasts an observatory with an 18-inch refractor.

At Johannesburg is the Union Observatory, with a 26-inch refractor. Both the University of Michigan and Yale University have established branches on the Union Observatory grounds with 27-inch and 26-inch refracting telescopes, respectively.

At Bloemfontein is the branch of the Harvard College Observatory, formerly located at Arequipa, Peru. This institution has now a 24-inch photographic refracting telescope and a reflector with a 16-inch mirror. A reflector with a 60-inch mirror is now being completed at Pittsburgh and will be installed at the Harvard Station. This will be the largest telescope south of the Equator.

[1] Part of the material in this article is taken from a biography of Professor A. V. Vasiliev by his pupil, Professor N. N. Parfentiev.

ORGANIZATION OF VIRGINIA ORNITHOLOGISTS

A GROUP of naturalists met at Lynchburg College, Virginia, on December 7, and formed the Virginia Ornithologist Society, having for its main purpose the promotion of the study of birds of the state. Ruskin S. Freer, professor at the college, was chosen president. About twenty were present, sessions lasting most of the day. The society is to be state wide and plans were formed for the functioning of the organization in several sections, among them being groups at Richmond, Norfolk and near Washington.

Perfection of the organization took up a greater part of the time of the gathering, with scientists from Blacksburg, Lexington and a member of the state game commission present, as well as Lynchburg naturalists. Mr. Freer said while the society is mainly for advancement of the study of birds, and for working with ornithologists of other states, the scope of its work would include the teaching of conservation of wild bird life, and educational work on the economic and esthetic values of birds.

At the suggestion of the Virginia Biological Survey and others interested in national work among birds, it was decided to compile a catalogue of Virginia birds, the work to require extensive research. It was also decided to publish a monthly bulletin for members. Dr. J. J. Murray, of Lexington, was chosen to edit the publication, to be assisted by a committee composed of Dr. J. I. Hamaker, of Randolph-Macon Woman's College; C. O. Handley, member of the state game commission of Richmond, and Miss Lena B. Henderson, of Randolph-Macon.

Among other things it was decided to send a radio message through KDKA Pittsburgh to George M. Sutton, who is spending a year on Southampton Isle, in the mouth of Hudson Bay, Canada, studying birds in that region of the North American continent.

The Lynchburg members will function as a state organization working in the Blue Ridge area. Organization of work in other cities for group study will begin shortly. Groups are to cooperate through corresponding members and in publishing the bulletin and state bird catalogue. Other officers of the society elected are, Charles O. Handley, of Richmond, state game commissioner, *vice-president,* and Miss Lena B. Henderson, *secretary-treasurer.*

After luncheon at Lynchburg College, the party went to Timberlake to participate in the monthly water fowl census.

THE NOBEL PRIZES

ACCORDING to a radio dispatch to *The Christian Science Monitor,* King Gustav, in the concert hall of the palace, recently distributed this year's Nobel prizes to six of seven recipients, there being one absentee, Professor Christian Eijkman. In the evening the Nobel Foundation gave a banquet honoring the winners, which was attended by the Crown Prince. The value of the awards given this year amounted to nearly $48,000 each.

The presentation ceremony was performed in the presence of the royal house and practically the entire government and diplomatic corps. Each recipient was welcomed by Governor Hjalmar Hammarskjold, president of the Nobel Foundation.

Attendance in person in Stockholm to receive the prize was one of the conditions made by the late Alfred Nobel, which it has not always been possible to fulfil, but on this occasion a large proportion of those to whom the prize was awarded were present, adding to the importance of the occasion. These included Thomas Mann, the German author, to whom the Swedish Academy decided on November 12 to award the 1929 Nobel prize in literature, and Prince Louis Victor de Broglie, the Frenchman who shared the year's prize in physics with Dr. Owen William Richardson, of London, who had planned a visit to Stockholm before he knew of the honor to be conferred on him.

Professor Hans von Euler-Chelpin, at present professor at the University of Stockholm, to whom the year's Nobel prize in chemistry was awarded by the Academy of Science, automatically attends, as he is also a member of the Nobel Committee. The prize in chemistry was shared by Professor Arthur Harden, of the University of London, who was also present. The Nobel prize in physiology and medicine was shared by Sir Frederick Gowland Hopkins, of Cambridge, and Professor Christian Eijkman, of Utrecht, the Netherlands.

THE FIRST INTERNATIONAL CONGRESS ON MENTAL HYGIENE

THE preliminary announcement of the First International Congress on Mental Hygiene has been sent out by John R. Shillady, administrative secretary, 370 Seventh Ave., New York City. The congress will be held in Washington, D. C., May 5 to 10, 1930. President Hoover has accepted the honorary presidency and delegates are expected from more than thirty countries.

The American Psychiatric Association and the American Association for the Study of the Feeble-minded will hold their annual meetings in Washington at the same time as the First International Congress, and hence the largest number of people interested in mental hygiene ever gathered together at one place and time will probably meet in Washington that week.

It is the purpose to have a maximum of discussion

and minimum of formal paper-reading. To this end papers at the morning sessions, printed at length in advance of the meetings, will be limited to ten minutes in statement, and discussion will follow. Afternoons will be given over to meetings of committees, prepared discussions not on the regular program, and recreation and sight-seeing. General sessions, designed to appeal widely to laymen, will be held on several evenings.

Members of the program committee are: Dr. Williams, chairman; Dr. C. Macfie Campbell, director, Boston Psychopathic Hospital and professor of psychiatry, Harvard University; Dr. William Healy, director, Judge Baker Foundation; Dr. Lawson G. Lowrey, director, Institute for Child Guidance, New York City; Dr. Howard W. Potter, assistant director, Psychiatric Institute and Hospital, New York City; Dr. Arthur H. Ruggles, superintendent, Butler Hospital, Providence, R. I.

In addition, persons residing in twenty-eight different countries are represented on the advisory committee on program. Besides these, the following are serving on the same committee, representing fields related to mental hygiene: *Anthropology:* Franz Boas, professor of anthropology, Columbia University; *Education:* V. T. Thayer, educational director, Ethical Culture Schools, New York City; *Eugenics:* Charles B. Davenport, director, Department of Genetics, Carnegie Institution of Washington; *Industrial Psychology:* Walter V. Bingham, director, Personnel Research Federation, New York City; *Nursing:* Effie J. Taylor, professor of nursing and superintendent of nurses, Yale University School of Nursing; *Philosophy:* M. C. Otto, professor of philosophy, University of Wisconsin; *Psychiatric Social Work:* Mildred C. Scoville, president, American Association of Psychiatric Social Workers; *Psychology:* Lewis M. Terman, professor of psychology, Stanford University, California; *Religion:* A. Eustace Haydon, associate professor of comparative religion, University of Chicago; *Sociology:* Ernest Watson Burgess, professor of sociology, University of Chicago.

SCIENTIFIC NOTES AND NEWS

Sir Ernest Rutherford gave his presidential address to the 267th annual meeting of the Royal Society at Burlington House on November 30. He then presented the awards which, as already announced, were as follows: Copley medal, to Professor Max Planck, Berlin; Royal medals to Professor J. E. Littlewood, Cambridge; Professor Robert Muir, Glasgow, and Professor G. N. Lewis, the University of California, and the Hughes medal to Professor Hans Geiger, Tübingen.

Dr. L. E. J. Brouwer, professor of higher mathematics in the University of Amsterdam, has been elected a corresponding member of the Prussian Academy of Sciences.

The Oscar Carlson gold medal of the Society of Swedish Chemists has been awarded to Professor Sven Odén for his work on sedimentation analysis and related subjects. The medal, which is awarded every five years, has been awarded only once before when it was given to Valdemar Jungner, inventor of the Nife alkaline storage battery.

A dinner was given by his colleagues in honor of Dr. Herbert Osborn, research professor of entomology in the Ohio State University, on December 17. Dr. Osborn joined the faculty of the university in 1898.

At the annual general meeting of the Cambridge Philosophical Society Mr. G. Udny Yule was elected president. The vice-presidents are Professor H. Lamb, Professor S. J. Hickson and Professor A. Hutchinson.

Dr. Veranus A. Moore, who recently retired as dean of the college of veterinary medicine of the New York State College of Agriculture at Cornell University, has been named superintendent of the Ithaca Memorial Hospital. Dr. Moore recently visited New York to study problems of hospital administration.

Professor Heinrich Ries, head of the department of geology at Cornell University, has been named to assist Dr. M. M. Leighton, chief of the Illinois Geological Survey, in working out plans for the Chicago Century of Progress Celebration in 1933.

W. A. Maw, assistant professor of poultry husbandry at Macdonald College, has been elected chairman of the program committee for the Canadian section of the Fourth World's Poultry Congress to be held in London, England, in July, 1930.

Lee A. Strong, assistant director of agriculture of the state of California, has been appointed chief of the plant quarantine and control administration of the U. S. Department of Agriculture. Dr. C. L. Marlatt, who has been filling the two positions of chief of the Bureau of Entomology and chief of the Plant Quarantine and Control Administration since July 1, 1928, retires at his request from the latter position in accordance with a plan which was authorized some two years ago.

A. D. Lewis, state director of mines and minerals for the last five years, tendered his resignation to Governor Louis L. Emmerson, of Illinois, on December 7. The resignation was made without explanation.

It is reported in the daily press that for the last four months the removal of Mr. Lewis from the head of the state department has been demanded by the Illinois district of the miners' organization and other labor organizations.

PROFESSOR R. B. THOMSON, head of the department of botany and professor of plant morphology of the University of Toronto, has been appointed a member of the International Scientific Agricultural Council with headquarters in Rome, Italy. This appointment has been made by the permanent committee of the institute.

LIEUTENANT-COLONEL W. P. MACARTHUR, professor of tropical medicine in the Royal Army Medical College, has been appointed consulting physician to the British Army in succession to Colonel J. C. Kennedy, who has been transferred to India.

At the University of California, Asher Hobson, professor of agricultural economics on the Giannini Foundation, who has been on leave for three months, loaned to the Federal Farm Board, has been granted an additional leave to June 30, 1930. It is understood that Professor Hobson will remain with the Federal Farm Board for one or two years. Dr. W. L. Howard, professor of pomology and director of the branch of the college of agriculture at Davis, has been given leave from April 1 to June 30, and Dr. W. I. Terry, clinical professor of surgery in the medical school, has been given leave from October 17 to February 1.

DR. W. V. BALDUF, of the University of Illinois, is spending a sabbatical year in Washington and has made arrangements to study Hymenoptera in the National Museum during a considerable part of the time.

DR. H. H. GRAN, of the University of Oslo, Norway, will again work on marine diatoms at the Puget Sound Biological Station in the summer of 1930. The work he did on the diatoms and the waters in the region of the station in 1928 with Dr. T. G. Thompson, of the University of Washington, and with Dr. E. C. Angst, of the University of Oklahoma, is partly in press and may be expected to appear in the publications of the station before next summer.

DR. EDMUND V. COWDRY, Washington University, St. Louis, has been asked by the British government to make a study of parasites in East Africa.

R. KENT BEATTIE, principal pathologist of the office of forest pathology of the Bureau of Plant Industry, who has been in Japan, Korea, Formosa and China studying chestnut blight and collecting blight-resistant chestnuts since July, 1927, expected to sail from Tokyo for Shanghai on November 29. From Shanghai he probably will go to Indo-China, Siam and the Straits Settlements, to study species of Castanea and Castanopsis. He expects to spend some time in the mountains of India and Burma. He will return through Europe, in order to study herbarium specimens and to examine plantations of Asiatic chestnuts.

THE Huxley Memorial Lecture of the Royal Anthropological Institute was delivered by Baron Erland Nordenskiöld in the lecture theater of the Royal Society on November 26. Baron Nordenskiöld chose as the subject of the address "The American Indian as Inventor."

THE fifth annual Norman Lockyer lecture in connection with the British Science Guild was delivered on November 19 by Sir Walter Fletcher, secretary of the Medical Research Council. The title of the lecture was "Medical Research: the Tree and the Fruit."

PROFESSOR G. P. THOMSON, of the University of Aberdeen, who is visiting lecturer at Cornell University this year, will address the Northeastern section of the American Chemical Society in January on "The Waves of an Electron."

THE Jacob H. Schiff Foundation Lecture of Cornell University was given on December 13 by Dr. Charles J. Chamberlain, professor of morphology and cytology in the University of Chicago, on "Field Studies of the Cycads in Australia, South Africa and Mexico."

DR. ERNEST W. GOODPASTURE, professor of pathology in the Vanderbilt University School of Medicine, Tennessee, delivered the third Harvey Society Lecture at the New York Academy of Medicine on December 19. His subject was "Some Phases of the Filterable Virus Problem."

AT a meeting of the Boston Bacteriological Club held at Walker Memorial Building, Massachusetts Institute of Technology, on December 7, Dr. George F. Reddish, chief bacteriologist of the Lambert Pharmacal Company of St. Louis, gave an address on "Methods of Testing Disinfectants and Antiseptics." Dr. Reddish was formerly chief bacteriologist of the food, drug and insecticide board of the Bureau of Chemistry in Washington, D. C.

DR. CHARLES E. SAUNDERS, formerly Dominion cerealist at the Central Experimental Farm, Ottawa, delivered an address before the Royal Canadian Institute, on "Wheat and Civilization" on November 3.

PROFESSOR ALEXANDER SILVERMAN, head of the chemistry department of the University of Pittsburgh, addressed the Cleveland section of the American Chemical Society on December 12 on "Some Recent Developments in Glass Manufacture."

DR. L. H. ADAMS, of the geophysical laboratory of the Carnegie Institution of Washington, gave an ad-

dress on December 19 before the Washington Academy of Sciences on "The Creation of the Earth and its Early Development." This is the first of a number of lectures proposed by the academy on various phases of genesis and development, or origin and evolution, which eventually, and as then brought to date by their several authors, may be assembled in book form.

The first Aldred lecture in the seventh series at the Massachusetts Institute of Technology was delivered on December 6 by Ralph Adams Cram. His subject was: "The Building of a Great Cathedral." The lecture was illustrated and described the construction of the Cathedral of St. John the Divine. The second lecture will be given on January 17 by Dr. C.-E. A. Winslow, of Yale University, on "Health Conservation—a Problem in Citizenship."

During the week of November 18–23 a series of lectures was given at Vassar College with the following program: Professor Roger Adams, of the University of Illinois, "Synthetic Organic Acids as Substitutes for Chaulmoogra Oil"; Dr. Harrison E. Howe, editor of *Industrial and Engineering Chemistry*, "Chemistry in the New Competition"; Dr. Florence R. Sabin, of the Rockefeller Institute for Medical Research, "Biological Effects of Different Chemical Fractions Isolated from the Tubercle Bacillus"; Professor Hugh S. Taylor, of Princeton University, "Speed and Sloth in Chemical Reactions," and Professor Henry C. Sherman, of Columbia University, "Chemistry."

The Pasteur Society of Central California met at the Hotel Whitcomb, San Francisco, on the evening of December 4, 1929. Dinner was followed by an address by Dr. K. F. Meyer, director of the Hooper Foundation for Medical Research, who recently returned from an extended visit through the countries of Europe. The address was followed by moving picture films of scenes and laboratories in Great Britain taken by Dr. Meyer. A picture of the Graf Zeppelin flight, a rabies film and two films on blood transfusion were also shown. The meeting was attended by 175 members and guests.

The Second Annual Pan-American Medical Congress and Exhibition will be held at Panama City, Republic of Panama, January 30–February 5. The congress will convene in the building of the Gorgas Memorial Laboratory, a research institution in tropical medicine which has been established in Panama by all the Latin-American countries. Delegates to this congress and exhibition will include the leading physicians, surgeons and directors of public and private hospitals and clinics of the twenty-one Latin-American republics, as well as many government officials.

The annual "Insect Exchange" was held at Frankfurt as usual at the beginning of November, according to the London *Times*. At present, as the custom goes, the chief barterers are men with butterflies and moths to exchange. The exchange is said to grow in popularity each year.

Plans and specifications for a house to be erected on The Effingham B. Morris Biological Farm as a residence for Dr. Milton J. Greenman, director of the Wistar Institute, are being prepared by Professor Paul Cret and his partner, Professor John Harbeson, both of the University of Pennsylvania.

The General Education Board has made a grant of $62,500 for the support of the Harvard Study of the Growth of Children, which is directed by Professor Walter F. Dearborn, of the graduate school of education.

Through the gift of the J. T. Baker Chemical Company, of Phillipsburg, New Jersey, the eastern fellowship in analytical chemistry will be available for the academic year 1930–31. The secretary of the committee of award is Professor Philip E. Browning, Yale University. The fellowship will be granted to an advanced student in analytical chemistry and the stipend is $1,000 annually. It is understood that the applicant will ascertain the requirements of the institution where the work is to be done. Consideration of the application will be facilitated if five copies are sent. Further information can be secured from the committee.

To aid the Soviet Republics in the development of large-scale farming through the use of machinery, Professor E. J. Stirniman, of the University of California agricultural engineering division, will spend a year in that country. He expects to arrive at his headquarters in Verblude, near the Black Sea, late this month. He will be employed as agricultural engineer by the Grain Trust of the Soviet government. The Grain Trust has about two and a half millions of acres in 15 or 20 units, and there will be 110,000 acres in the experimental farm at Verblude where Professor Stirniman will be stationed. He will have a staff of 42 men, 10 of whom have already left for Russia; 32 still are in training in the machinery and tractor factories in the United States.

A session of the subcommission for peat soils will take place in Leningrad and in Moscow, U. S. S. R. (Russia), from July 20 to August 2, 1930, in connection with the meetings of the Sixth Commission and the Second International Congress of Soil Science. The session will be devoted to the reading and discussion of papers dealing with (1) stratigraphy, (2) profile analyses and (3) cultural operations of peatlands. A comparative study of certain regional areas of "low moor" has been proposed with the view to

adopting a uniform procedure and terminology in peat investigations. Members who are interested and may wish to present papers or attend the meetings are invited to send a brief summary of their paper to Professor Dr. A. A. Yarilov, president of the organizing committee, Iljinka, Karuninskaja 1, Gosplan, Moscow, U. S. S. R.

A CALENDAR issued from the British Ministry of Agriculture shows the dates fixed for the World Poultry Congress and the addresses of the national committees in 30 countries. On July 21, 1930, there will be an official reception of delegates by his Majesty's Government, and the congress opening ceremony will take place on the following day. The congress closes on July 30, and from July 31 to August 12 the delegates will make a tour of Great Britain, Northern Ireland and the Irish Free State. January 31 is the last day for receiving applications for space for national exhibits. Live-stock entries, from home and abroad, must be made by March 31, and all papers to be read at the congress must be in the hands of the congress secretary by February 28. Already the demand for space has been so great that very little more is available, and it has been decided to provide accommodation for live stock in parts of the Crystal Palace grounds as well as in the main building. Thanks to the cooperation of several well-known horticultural firms, there will be displays of flowers and plants.

THE Harvard Botanic Garden, hitherto a separate department of the university, has been transferred to the department of botany. President Lowell has given out the following statement in connection with the change: "Some years ago a number of people interested in gardening asked the corporation to conduct the garden for horticultural objects, offering to pay the expenses involved, which the corporation was glad to do so long as the cost was thus defrayed. After a while the committee became weary of raising subscriptions, and last spring it was decided that in view of this fact, and of the comparatively small scientific value of horticulture to the university, the garden had better be used for scientific purposes. The direction of the garden has, therefore, been transferred to a member of the department of botany, Dr. R. H. Woodworth, who will use the small income of the endowment for the benefit of that department." The Botanic Garden was established in 1805. The plan of its founders was to grow in the garden "all the plants that may be procured and may be capable of preservation therein." In recent years the garden has provided the department of botany with living specimens to be used in lectures and laboratories, maintained a seed exchange with institutions in this country and abroad and offered opportunity for study to amateur gardeners and the public generally.

CONTINUOUS weather information for pilots of aircraft, and for the 24 hours of the day if flying schedules so require, is the objective of the Weather Bureau in its service for aviation, but larger appropriations than have been available will be necessary, says C. F. Marvin, chief of the Weather Bureau, in his report to Secretary Hyde for the year ending June 30. Professor Marvin comments upon the advances made in the international movement for reporting and forecasting weather at sea, and also refers to the economic returns from the Weather Bureau services of warnings against frosts and against conditions favorable to the spread of forest fires. Under informal agreement the principal maritime nations of the world now enlist ships of their own registry. These ships observe and report weather conditions at least twice a day. Forecasts indicated by these reports go into the international exchange of weather information by radio. About 50 United States ships are now making these reports while they are at sea.

DR. DEAN F. SMILEY, medical adviser of Cornell University, announces that an ultra-violet ray solarium has been installed on the top floor of the Old Armory, and that irradiations are available to all men students. This is said to be the first ultra-violet ray solarium to be established in an American university, and marks the beginning of a comprehensive effort to make available artificially the helpful effects of the rays of the sun to students at Cornell University. As a result of experiments performed over a long period of years, Dr. Smiley, together with Dr. George H. Maughan, of the department of physiology, has shown that common colds can be prevented to a considerable degree by the use of ultra-violet rays. Two types of ultra-violet rays will be available. One section will consist of 16 fifty-inch mercury tubes with aluminum reflectors. They are arranged in perpendicular positions around the room. A student taking the rays proceeds between two rows of tubes, standing in front of each position for one minute. A clock rings automatically, giving the signal to advance to the next position. In addition to the vertical tubes, there are two overhead tubes which make it possible for the entire body to receive the ultra-violet rays. The intensity of the artificial rays is stronger than sunshine at noon on the brightest day. Another section of the solarium contains 5 carbon arc lamps, and the same system prevails for advancing the patient from one station to another. The lamps have hollow carbons which contain various metals, particularly aluminum, iron and nickel. These when heated to white heat give off a high amount of ultra-violet as well as some of the visible spectrum and infra-red rays.

UNIVERSITY AND EDUCATIONAL NOTES

CYRUS H. K. CURTIS, Philadelphia publisher, has given Ursinus College $200,000 to start a fund for a new natural science building which will cost $450,000.

DR. GEORGE H. CLAPP recently made a gift of $15,000 to the endowment fund of the Carnegie Institute, Pittsburgh. This is the second donation to the institute by Dr. Clapp to be duplicated by the corporation. His previous gift amounted to $25,000.

DR. DANIEL J. MCCARTHY has been appointed director of the newly established neurological foundation of Temple University, Philadelphia.

PROFESSOR H. E. CLIFFORD has been appointed acting dean of the engineering school of Harvard University during the absence of Professor Hector J. Hughes, who has leave of absence for the second half of the academic year.

THE appointment of Dr. Alfred E. Emerson as associate professor in the department of zoology is announced by the University of Chicago. Dr. Emerson, who went to Chicago from the University of Pittsburgh, will have charge of developing the work in the general biological aspects of entomology.

DR. JOHN WYLLIE, of Glasgow, has been appointed to the new Elliot chair of public health and preventive medicine at Queens Medical College at Kingston, Canada, established through the gift of $50,000 from Samuel Insull, of Chicago.

G. G. MOE, associate professor of agronomy at the University of British Columbia since 1922, has been promoted to a professorship and appointed head of the department.

PROFESSOR F. E. WEISS will retire at the end of the present session from the George Harrison chair of botany and the directorship of the botanical laboratory of the University of Manchester. He has held these appointments since 1892.

DISCUSSION

M MU VERSUS MU MU

IN this journal for November 8, 1929, may be found on page 453 a note by Mr. John P. Camp entitled "The Micrometric Muddle." It includes the following sentences:

> Certainly the system should be definitely put in order. What to do about it is not so easy to decide; for though it might seem proper to insist on strict adherence to the present authorization of the Bureau of Standards it can be argued that their system is that of the physicists who are a minority and that the biologists and chemists besides being greatly in the majority use the terms and symbols most widely distributed in scientific literature.

In this journal for March 4, 1927, on page 233, I devoted twenty-one lines to indicating that mμ and μμ should mean, respectively, the 10^{-9} and 10^{-12} parts of the meter. In that note the suggestion contained in the next quotation was made to account for the origin of the error involved in taking μμ to represent 10^{-9} meter, *i.e.*, 10^{-6} mm. "Probably this error arose from the following sequence of folly: 1 μ equals 0.001 mm, hence the symbol μ denotes the multiplier 10^{-3}. Therefore μμ must mean (10^{-3}) (10^{-3}) mm or 10^{-6} mm." Doubtless the use of the word "probably" weakened the main argument to such an extent as to prevent the earlier note from receiving the serious attention of many open-minded readers.

In the present note it will be shown beyond peradventure that the only consistent and logical definitions of mμ and μμ are 10^{-9} meter and 10^{-12} meter, respectively. In order to prove my point it will be necessary to review the history of the origin of the symbol μμ. This history should not be without interest for the reasons that it does not seem to be sufficiently well known and that it throws helpful sidelights on the question of the alleged "muddle."

In the year 1883, J. Springer published a book, entitled "Lehrbuch der Spektralanalyse," from the pen of a very prominent physicist, Professor Heinrich Kayser, to whom experimental spectroscopy owes an incalculable debt. The following quotation is a true translation of the footnote occurring on page 11:

> Here, as well as throughout the entire book, the wave lengths shall always be given in millionths of a mm. Since there still exists no simple notation for this quantity and as it is the most suitable for all wave measurements, I have introduced for it the new notation μμ which is derived from the symbol μ, for a thousandth of a mm, just as mm is obtained from m. Accordingly we may have the lengths: m, mm, μ, μμ each of which is the one one-thousandth part of the preceding unit.

This idea is faulty and unjustifiable in at least two respects. In the first place it is tacitly admitted by Kayser that the left-hand m in mm denotes one thousandth, and that m had this signification prior to his knighting the Greek μ to the Order of the Thousandth. Hence, even in the same line, he writes two different symbols having the same operational power, that is, 10^{-3}. This procedure is unscientific since it adds a superfluous quantity to the terminology and thus violates a canon of beauty demanded of scientific presentation—brevity consistent with clarity and generality.

Again Kayser's premise ". . . the symbol μ, for a thousandth of a mm, . . ." is false. The unit of length in the metric (metre-ic) system was, and still

is, the meter. In spite of all the inconsistencies that have been introduced into non-mathematical literature and into the English dictionaries and encyclopedias by the fluent confusion makers, μ has escaped contamination as yet in the Encyclopaedia Britannica. On page 739 of Vol. 27 of the thirteenth edition of this incomparable (though not infallible) work may be found: "Another relatively minute unit is the 'micron,' denoted by μ, and equal to one millionth of a metre; . . ." In the fourteenth edition, Vol. 17, page 877, is written: ". . . or again the 'micron,' denoted by μ and equal to one millionth of a metre is employed." The micron is numerically equivalent to each of the following measures—10^{-3} millimeter, 10^{-4} centimeter, 10^{-5} decimeter, 10^{-7} decameter, 10^{-8} hectometer, 10^{-9} kilometer and 10^{-10} myriameter. The micron can not be *defined* legitimately in eight different ways and Kayser chose arbitrarily one of the seven possible unaccepted and unacceptable ways of defining μ in order to arrive at the unfertile hybrid notation μμ. Even in the c. g. s. system of units the millimeter does not occur as the independent or definitional unit. There is no m (millimeter) g. s. system.

Kayser's argument is not based on fact to a greater extent than the following specious reasoning. The symbol mm is a special case of a general rule which states that when a symbol is repeated once the first or left-hand letter acts as an operator signifying the one one-thousandth part of the second or right letter which denotes the unit (operand) involved. It follows at once that the abbreviations for milliampere, milligram, milliliter, millivolt, millimicron, etc., should be respectively the pretty self-conjugate pairs aa, gg, ll, vv, μμ, etc.

The disillusionment with regard to μμ as 10^{-9} meter is far from being of recent origin. In the *Archiv der Pharmacie* published by the Deutschen Apotheker-Verein may be found (in Vol. 232, pp. 3–36) an article by a chemist, Dr. Hugo Erdmann, which was received by the journal on December 10, 1893. The translation of the title is: "The Salts of Rubidium and their Importance for Pharmacy." Erdmann consistently expresses his wave-lengths in terms of mμ and he makes the following sententious remarks in a footnote on page 10. A faithful translation of this footnote constitutes the next paragraph:

> I emphasize this [matter] in this place too for the reason that nowadays great confusion still obtains in the notation for this small measure. Thus Kayser and Runge as it suits them (*e.g.*, page 12) make use of the millimicron as unit which however they denote by μμ instead of by mμ and then again, without further explanation, they go over to another measure, to the "tenth-meter" which is in general use in England and is also called the "Ångström unit." Furthermore reduction is simple because a tenth-meter = 10^{-10} m is the tenth part of a millimicron mμ. (*Cf.* H. Erdmann, on orders of magnitude, *Zeitschr. f. Naturwissenschaften*, 1893, 66, 73).

There remains only one conclusion, that mμ and μμ should denote the 10^{-9} and 10^{-12} parts of the meter, respectively. Incidentally, I now desire to retract the use of the word "probably" in my earlier note.

It is certain therefore that many years ago a *physicist* started the symbol μμ with its inconsistent signification and that a *chemist* showed clearly the unsatisfactory character of the physicist's definition. The apparently general adoption of μμ as 10^{-6} mm was probably due largely to the following causes: (a) The scientific authority of Professor Kayser which retarded the day of emancipation in a manner analogous to the obstacle placed unintentionally by Sir Isaac Newton in the way of the designing of achromatic lenses. (b) The extremely frequent occurrence of μμ after the numerics of optical wave-lengths in numerous valuable papers by Kayser and his students advertised the unit in question very extensively. (c) The intensive prosecution of experimental research in a special field requires so much time, energy and concentration that it often gives rise to potential indifference as to the credentials of units borrowed from another field so long as they seem to be properly sponsored and to be of noble birth and ancestry.

With regard to Mr. Camp's unguarded use of the epithets "minority" and "majority" with respect to physicists on the one hand and to biologists and chemists on the other hand, and to his implications in general, I should like to call attention very briefly, but in the best of humor, to a few considerations.

As an immediate consequence of the quantitative nature of physics, as well as of the mathematical and experimental technique of this science, the need for permanent representative units was first recognized by physicists. For this reason (and not because of any inherent superiority) the definition, design, construction, calibration and preservation of prototype standards of length, mass, etc., have been entrusted to them.

Again, if mere numbers of human beings count for anything in the realm of the natural sciences then radio waves are propagated by the atmosphere (so-and-so is "on the air"), John the Baptist subsisted

> From the universally accepted notation μ for the micron or one millionth of a meter it follows quite naturally that by μμ is to be understood a millionth of a micron, while one has to write one thousandth of a micron or millimicron mμ, precisely as one writes a thousandth of a meter mm. Hence the following measures for small linear magnitudes result:
>
$1\ m = 10^{0}\ m$	$1\ \mu = 10^{-6}\ m$	$1\ \mu\mu = 10^{-12}\ m$
$1\ mm = 10^{-3}\ m$	$1\ m\mu = 10^{-9}\ m$	$1\ m\mu\mu = 10^{-15}\ m$

partly on cicadas (the "man-on-the-street" calls them locusts), steam is visible (white), lightning follows zigzag paths with sharp bends, mammals of the order Cetacea (porpoises, dolphins, whales, etc.) are fishes, the tongue of a snake is its "stinger," moist air is heavier than dry air, etc., etc.

H. S. UHLER

YALE UNIVERSITY

MATHEMATICS AND THE TRUTH

IT is frequently said that the modern mathematician does not ask whether a certain result which he regards as established is true but that he is interested only in proving that it can be derived from the system of postulates which he has formulated. While it would be difficult to determine the amount of mathematical work which is now being done in such a philosophical frame of mind it would doubtless be safe to say that this amount is relatively very small. If one listens to papers presented at the meetings of mathematicians one can not fail to notice that there is a remarkable degree of confidence in the truth, and hence permanent character, of the new results which are being communicated. It is seldom that any reference is made to the system of postulates which are ultimately involved and it is quite likely that many of the most successful investigators would find it difficult to exhibit these postulates if they should be asked to do so.

As far as we know now the ancient Greeks were the first to realize the fact that mathematical reasoning must ultimately be based on postulates, and hence that the results with which mathematicians deal can be regarded as true only if these postulates are true. Recent discoveries have established the fact that the pre-Grecian mathematical developments were much more extensive than had been previously assumed, but these discoveries have not yet exhibited any system of postulates which antedates those of the Greeks. It is a very interesting fact in the history of scientific ideas that all known evidences support the view that before the ancient Greek civilization mathematical results were regarded as truths which were not ultimately dependent upon systems of postulates. The Greeks seem to have originated the philosophical frame of mind as regards mathematical results, and they fortunately also greatly extended these results so as to provide ample material for the activities of those who accept as true much that they themselves have not traced back to the ultimate postulates.

The popular orator who seeks to clinch a statement by saying that it is mathematically true conveys thereby a more useful view of mathematics than the critical student who observes that nothing can be really proved in mathematics since it is necessary to assume some things before you can reason about any question. Both those views are in order under appropriate circumstances, and they supplement each other. To exhibit the Greek view as regards the necessity of postulates in the development of mathematics we quote the following from Aristotle's Posterior Analytics:

> By first principles in each genus I mean those the truth of which it is not possible to prove. What is denoted by the first [terms] and those derived from them is assumed; but, as regards their existence, this must be assumed for the principles but proved for the rest. Thus what a unit is, what the straight [line] is, or what a triangle is [must be assumed].

What is perhaps of more importance in this connection is the fact that Aristotle not only knew that some of the postulates of mathematics can not be proved but he also saw that they do not necessarily appear self-evident to the beginner. This is shown in the following statement found in the work to which we referred in the preceding paragraph:

> Now anything that the teacher assumes though it is a matter of proof is a hypothesis if the thing assumed is believed by the learner, and it is, moreover, a hypothesis, not absolutely but relatively to the particular pupil; but, if the same thing is assumed when the learner either has no opinion on the subject or is of a contrary opinion, it is a postulate.

Hence it appears that at least some of the ancient Greeks looked at mathematics and the truth in about the same way as we do now. This is a very important fact in the history of the development of mathematical ideas, especially since during some of the intermediate centuries the postulates of mathematics seem to have been regarded as self-evident truths. The development of non-Euclidean geometry exerted a powerful influence towards making the function of the postulates in elementary geometry more widely known.

Some of the Greek writers called attention to what appeared to them as different properties of postulates and axioms, and many of the modern writers have followed them in this regard. On the other hand, there are those who see no essential differences between the concepts represented by these terms. The relation between mathematics and the truth is, however, not affected thereby. If at least one of the two terms axiom and postulate was used by the Greeks to represent a concept which was not regarded as self-evident they must have realized the philosophical difficulties involved in regarding mathematics as true in the sense that it is possible to establish a contradictory system based upon another set of postulates. O. Neugebauer recently directed attention to the fact that an important feature of pre-Grecian mathematics is that it excludes the concept of irrationality which plays such a fundamental rôle in the mathematics of

the ancient Greeks. From what precedes it results that another very important feature of pre-Grecian mathematics is that it does not involve the concept of postulates, which also plays a fundamental rôle in Greek mathematics and in the connections between mathematics and the truth.

G. A. MILLER

UNIVERSITY OF ILLINOIS

THE DEVONO-MISSISSIPPIAN BOUNDARY IN THE SOUTHEASTERN UNITED STATES

STUDIES made in Tennessee and Virginia under a grant from the Rockefeller Fund for Research in Pure Science of the University of North Carolina have led to the following observations and conclusions.

The Chattanooga shale in the type area at Chattanooga, Tennessee, is entirely Mississippian in age. From Chattanooga it can be traced through northeastern Tennessee into southwestern Virginia where it gradually fingers out, finally disappearing near Holston, Virginia. Throughout most of this region it maintains its typical threefold division into upper Big Stone Gap black shale, middle Olinger gray shale and lower Cumberland Gap black shale members. In Virginia, in the Clinch Mountain area, the gray Olinger shale rapidly becomes black also and merges with the overlying Big Stone Gap and the *upper* part of the underlying Cumberland Gap members to form a single black shale series. At the same time the *lower* part of the Cumberland Gap shale, which has here become a black to gray-black shaly sandstone, splits into a series of wedges which intertongue with sandy shales and shaly sandstones carrying an upper Devonian (Chemung) fauna. It thus follows that the lower part of the Cumberland Gap member is Devonian in age while the upper part is Mississippian, as proved in 1927.[1] The Devono-Mississippian boundary lies, therefore, *within* the Cumberland Gap black shale member and can be represented by only a slight stratigraphic break, if indeed by any at all. Its unimportance is further emphasized by the following facts. 1. At the southern end of Clinch Mountain black shale deposition extends without interruption across the boundary, the Chemung and Chattanooga beds uniting in one continuous black shale series. 2. The overlap of the upper Devonian beds towards the southwest continues, without sign of a regression of the sea, across the boundary and on through lower Chattanoogan times. 3. Conglomerates just below the Chattanooga in the upper Chemung, which by some geologists have been regarded as marking the boundary, are all purely local and intraformational in character.

Towards the west and southwest the Devonian portion of the black shale rapidly wedges out and the Chattanooga becomes, as in the type area, entirely Mississippian in age, and probably so continues across the Mississippi River into the southwestern United States.

In view of the Mississippian age of the Chattanooga shale at Chattanooga, Tennessee, the term "Chattanooga" should be restricted to the Mississippian portion of the shale, if it becomes feasible to separate it from the underlying Chemung black shales. A distinct formational name should then be applied to the latter.

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[1] "Chattanooga Age of the Big Stone Gap Shale," *Amer. Jour. Sci.*, 14, 1927: 485–499. *Cf.* also: "Age and Stratigraphy of the Chattanooga Shale in Northeastern Tennessee and Virginia," *Amer. Jour. Sci.*, 17, 1929: 431–448.

PORTO RICAN AND DOMINICAN STRATIGRAPHY

THE following stratigraphic sequence of Porto Rican sedimentaries is a revision suggested in the light of advancing knowledge.

Pleistocene to Recent: Dune sands, Alluvials, Playas, San Juan formation. *Lower Miocene:* Ponce chalk beds, Quebradillas limestone, Aguadilla limestone. *Upper Oligocene:* Lares and San Sebastian beds, Guanica limestone, Lower Ponce beds, Juana Diaz shales. *Upper Eocene:* Rio Descalabrados and La Muda deposits. *Middle Eocene:* Rio Jueyes beds. *Upper Cretaceous (Maestrichtian):* San Germán deposits, Enseñada shale, Fajardo and Cape San Juan limestones. *Lower Cretaceous:* (?) Limestone south of Cidra. Doubtful, but possibly equivalent to the Fredericksburg.

Regarding Dominican Republic sedimentaries, I now refer my Gato beds to marine Pliocene, and my Caimito beds to Upper Miocene.

In 1917, I made my Cercado and Gurabo formations the types of Lower and Middle Antillean Miocene, respectively. Lately Dr. Woodring has placed the division between Lower and Middle Miocene below the Cercado, running it up into Middle Miocene. But the association of *Ostrea cahobasensis* and *Orthaulax aguadillensis* in the May Pen limestone, Jamaica, draws the Las Cahobas and equivalent Cercado relationship downward. Furthermore, the Bulla which grades into the Cercado is probably, as Dr. Vaughan thought, largely contemporaneous with the Baitoa. Therefore it seems to me a truer time relation that the Cercado should remain as type of the Lower Miocene of the Antilles.

CARLOTTA J. MAURY

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"FEED A COLD AND STARVE A FEVER"

ON page xiv of SCIENCE for November 22 is this statement, "Nothing could be farther from the right than the injunction, 'Feed a cold and starve a fever.'" Quite correct, if it is an injunction, as probably the great majority understand it to be, but isn't it really a warning, to the effect that if you do eat heavily when you have a cold you may expect to get worse and have a fever to starve? "Lie down with dogs and get up with fleas," "Spare the rod and spoil the child" and a lot of other similar sayings in telescoped English are not injunctions by any means, but wise maxims of the same elliptic type as the one about stuffing when you have a cold—all from the same piece of cloth, and fine cloth it is, when worn right side out.

W. J. HUMPHREYS
U. S. WEATHER BUREAU

QUOTATIONS

BIOCHEMISTRY AND MEDICINE

THE award of the Nobel Prize for medicine jointly to Sir Frederick Hopkins, of Cambridge, and Professor C. Eijkman, of Utrecht, and for chemistry to Professor Arthur Harden, of the Lister Institute, and Professor H. von Euler, of Stockholm, can not but give the greatest satisfaction to the medical profession and to scientific workers in this country. Both of the English workers are biochemists and both are notable as pioneer workers in various fields, which, once opened up by their efforts, have produced an increasingly rich crop of knowledge. It is notable that Harden, like Pasteur before him, chose yeast as the subject of his investigations. His experiments revealed a hitherto unsuspected phase in the process of alcoholic fermentation—namely, the formation of the intermediary hexose phosphoric esters. Following his lead, other workers demonstrated that these substances played an important part in the story of muscular activity, and it is now realized that phosphoric esters have a significance in animal metabolism which was undreamed of before Harden made his fundamental observations. Hopkins and Eijkman received the prize for their work on vitamins. Eijkman first described beriberi as a clinical entity, and showed that it was in some way connected with a diet of polished rice. To Hopkins we owe the conception of "accessory food factors," and it was he who first demonstrated that these were definite physiologically necessary entities, quite distinct from all other known dietary substances. Characteristically, he was more interested in the discovery itself than in his personal claims as its author, and the facts found a place in his lectures for three or four years before the publication of his first paper on the subject. He used to say in these lectures that, while at hospital in the eighteen-nineties, he was profoundly impressed by the unsatisfactory state of knowledge about the essentials of nutrition, when only "protein" and "energy" were considered, and the profound effect of "quality" as distinct from "quantity" in diet was unrecognized alike by the physiologist and the clinician. This conviction suggested much of his later work. At first his views were not accepted, but scepticism was overwhelmed by the mass of confirmatory evidence, which has now grown into an extensive literature—so extensive, indeed, that Hopkins's earlier papers are in danger of being forgotten. It is fitting, therefore, that his work on vitamins should have been the occasion of the international recognition that he has just received. Sir Frederick Hopkins's biochemical interests have been, however, extraordinarily wide. With Sir Walter Fletcher he laid the foundations upon which has been built almost all the work on muscle physiology as we know it to-day. Early in his career he showed that the pigments of the wings of Pierid butterflies were composed of uric acid and its derivatives, and his method for the estimation of uric acid is still the most reliable at our disposal. His excursions into the realm of protein chemistry resulted in the preparation of the first animal protein to be obtained in a chemically pure state. Next, led by his work on the Adamkiewicz reaction, he discovered trytophane, and proceeded to demonstrate that its presence in the diet (and also that of a few other complex amino-acids) was essential to life; incidentally, in the course of this work he was among the first to make use of bacterial activity as a means of determining molecular constitution. He has been responsible for most valuable, though little-known, work on that curious substance, Bence-Jones protein. His investigations into the mechanisms of biological oxidizations have done much to bring order into our knowledge of a subject of fundamental importance. Among other observations, his demonstration of the presence of xanthine oxidase in milk has made possible much of the accurate quantitative work on oxidases which has of late figured prominently in the output of the Cambridge school. Finally, he has isolated from tissues a new tripeptide, glutaminyl-glycyl-cysteine, which undoubtedly plays an important part in the oxidization processes of living cells. There can be few physiologists or biochemists in this country who are not proud to acknowledge how much they owe to Hopkins's influence and teaching; and this feeling is certainly shared by all physicians who appreciate the great and increasing debt of clinical medicine to biochemistry.—*The British Medical Journal.*

SCIENTIFIC APPARATUS AND LABORATORY METHODS

AN ISSUE RAISED IN "A NEW TYPE OF LYSIMETER AT THE NEW JERSEY AGRICULTURAL EXPERIMENT STATION"

UNDER the caption, "A New Type of Lysimeter at the New Jersey Agricultural Experiment Station," SCIENCE, 70: 147, Dr. J. S. Joffe describes the Russian type of lysimeter and enumerates what he considers to be its distinctive advantages. The statement, "The only rational method of studying the drainage of each horizon is to install a series of lysimeters at the depth of the respective horizons *without disturbing the natural position of the soil profile.*"[1] is one that raises an interesting issue. If this unqualified statement be true, it means that during the past twenty years the properties of the several profiles of different soils have been studied by an irrational method at the Tennessee Station, and with three types of equipment.[2] The same fallacy would apply to similar studies at several other stations in this country, as well as in England, Germany and Switzerland. The writers believe that the above-mentioned article offers a timely occasion for the presentation of the two view-points that have been considered in a previous contribution.[3]

Lysimeter researches have for many years been based upon these two view-points. One of them calls for a built-up enclosure around an area of undisturbed soil for each lysimeter unit. This postulates homogeneity in the soil and subsoil of the area chosen for study. This homogeneity can be proved only by physical and chemical examination when the enclosed area shall have been disrupted after the termination of the experiment; hence periodic reports of different phases of the studies can not be made with safety. The other view-point demands homogeneity as the first prerequisite, and this is assured by a premixing of the soil required for each experiment. With assurance of initial uniformity, periodic reports of the progress of the main objectives and by-product findings may be offered as the investigation proceeds. In both conventional types the retaining walls extend above the surrounding surface, so as to preclude the effects of surface washing.

Our concept of the value of the lysimeter is that it serves as a means of establishing fundamental principles that relate to *cultivated* soils and their subsoils. Most of the cultivated soils in our humid regions receive some manurial treatment. The fate of such additions is of academic interest, as well as practical importance. The lysimeter is of especial value in this connection.

Our own opinion is that homogeneity in the soil mass is the paramount essential in lysimeter experiments. This can be assured at the beginning of an experiment only by a thorough mixing of the body of soil that is to be divided among the several containers. Initial uniformity in the soil systems in the different units is imperative when supplementary laboratory studies of residual effects and causative factors are to be made.

When properly carried out, we believe preliminary screening and mixing constitute a treatment that is hardly more severe than a thorough field preparation for a common farm crop. To contend that the prescribed mixing materially alters a given soil is equivalent to contending that the repeated field cultivation of that soil results in its being converted into a series of materially different soil systems. Extended observations have shown that the initial acceleration in biochemical activities and the enhanced outgo that may result from the preparatory handling is followed by years of uniform outgo, under normal climatic conditions. The close agreement obtained in the outgo of nutrients from replicated lysimeters has further justified the efforts to insure the uniformity that is attained by premixing. The practicability of the premixing plan also permits the economic installation of a large number of filled units, instead of a restricted number of built-up enclosure units, for the same expenditure.

The new, or Russian, no-wall type of lysimeter that is advocated by Dr. Joffe requires further and even more optimistic postulation than that called for by the built-up enclosure type. Homogeneity is hoped for, or assumed, and this assumption is burdened by the further assumption that the percolation follows a definite perpendicular direction in the absence of the side walls that are used in the two older types. With increase in depth of profile, this assumption becomes more hazardous, especially in gravelly soils and those of glaciated regions. The assumption as to perpendicular movement of percolates in the absence of retaining walls also minimizes the variations that may be introduced by ducts that result from decayed plant roots, as well as worm channels. Under some conditions and with certain types of soil and terrain, the major portion of the gravitational movement probably is directly downward. Nevertheless, the lateral seepage that causes trouble in perpendicular concrete walls tends to create skepticism concerning this point. The question of the direction of gravitational water movement through a soil column has been controversially considered by Greene and Ampt, and Thorpe and Roger, and by Leather, who states:[4] "But the passages

[1] Italics are ours.
[2] Tennessee Sta. Bul. 111, 1915.
[3] *Jour. A. O. A. C.*, 7: 16, 1928.
[4] *Jour. Agr. Sci.*, 4: 304, 1912.

through the soil are not straight or of uniform diameter for any measurable distance, in fact they are wholly irregular, which Greene and Ampt recognize, for they describe them as 'irregular in area, length, direction and shape.'" Furthermore, exactness in the increment of rainfall per unit of soil surface is not assured in the Russian type, since no control of surface run-off is provided. Certain studies at the Tennessee Station have required separate collections of percolates and the surface run-off from rainfall within lysimeter walls, and from observations made in these studies we are convinced that the factor of run-off can not be disregarded.

The Russian type of installation has economy as a point in its favor, but it will not prove economical unless its operation affords dependable results. The requisite expenditure of time, money and scientific labor will have been made before the validity of the results is determined.

Dr. Joffe states, "It is well to remember that such an outfit may be installed anywhere and if the data obtained were either unsatisfactory or *(in)complete*[5] for any particular purpose, the lysimeter funnels might easily be dug out and placed elsewhere." The implied uncertainty carried by this statement will hardly appeal to those who have labored to perfect types of containers that have proved to be dependable for study of soil and subsoil horizons to a depth of six feet.

The suggestion of a new type of equipment for the study of fundamental objectives arouses interest, and an *a priori* criticism would not be advanced by us if the Russian equipment were not offered as essential to a "rational" procedure in studies made by us and others through the use of related types of equipment. We readily concede that individual workers are entitled to the prerogative of choosing the apparatus that they believe will best serve their respective needs. We do not concede, however, that the introduction of a new and comparatively untried type of lysimeter justifies the inference that the use of an extensively tried and proved type is irrational.

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SPECIAL ARTICLES

TRANSMISSION OF EXPERIMENTAL TRACHOMA BY CONTACT

DR. NOGUCHI'S work, already confirmed in the United States and Europe, associates etiologically *Bacterium granulosis* with human trachoma. This association is based, first on the frequent, probably constant, presence of the bacterium in the lesions; and also on the fact that when *Bacterium granulosis* is inoculated into rhesus monkeys and chimpanzees by subconjunctival injection, corresponding granulomatous lesions are produced. Experienced ophthalmologists have identified the experimentally produced lesions with the typical lesions of human trachoma, and there are great similarities between the two shown by the microscope.

The usual course of the development of the lesions in inoculated monkeys, as described in Dr. Noguchi's monographic article,[1] is, first the appearance of the granular lesions on the upper inoculated conjunctiva; then on the lower membrane, and later the extension of the lesions to the upper and lower conjunctivae of the opposite, uninjected eye.

This succession of events indicates quite unmistakably that while for the initiation of the lesions in apes a subconjunctival injection of the culture may be necessary or is the surest way of establishing infection, the subsequent processes depend on the contact of the lesions, or the secretions from the lesions, with the uninjected conjunctivae.

In order to procure this contact infection beyond doubt, four rhesus monkeys were caged together. Two of the four had advanced granular lesions produced in the one case by the injection of Albuquerque strain No. 1 isolated by Dr. Noguchi in 1926, and in the second by the injection of the same strain recovered in 1928 (Tyler) from the eye lesions of a monkey previously injected with the same Albuquerque strain. The remaining two monkeys were normal, with entirely smooth conjunctivae, at the time of exposure.

The animals were placed together in a roomy cage on November 8, 1929. They were examined eighteen days later, or on November 26. The two monkeys already affected showed, of course, advanced lesions. The two exposed monkeys, which had normal conjunctivae on November 8, now showed in each instance granulomatous lesions affecting the upper and lower conjunctival membranes of both eyes.

There seems, therefore, no doubt that *Bacterium granulosis* can be carried to and made to infect the uninjured conjunctiva of *Macacus rhesus* through ordinary contact. This possibility, already shown by the extension of the lesions from the injected to the uninjected eye by Dr. Noguchi, is now shown to be

[5] In a communication to the writers, Dr. Joffe requested that this word be corrected to read "complete."

[1] Hideyo Noguchi, "The Etiology of Trachoma," Supplement No. 2, *Jour. Exper. Med.*, 1928, xlviii.

capable of achievement through the caging together of inoculated and uninoculated animals.

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THE LIFE HISTORY OF THE SWINE KIDNEY WORM

INTRODUCTION

STEPHANURIASIS, or kidney worm disease of swine, as determined in the course of the investigations which are briefly reported in this paper, is a more or less generalized parasitic infestation, of relatively long duration, the causative agent being a nematode known to zoologists as *Stephanurus dentatus,* commonly called the swine kidney worm. The parasites invade the abdominal viscera, notably the liver, pancreas and spleen; the thoracic viscera, notably the lungs; the circulatory system, especially the portal vein and its branches, the gastro-hepatic artery and the posterior vena cava; the thoracic and abdominal cavities, the lumbar muscles, the diaphragm, the outer coat of the stomach and intestine, the perirenal fat, the kidneys and other organs and tissues. Coincident with the sojourn of the parasites in the various parts of the body, profound pathological changes are produced in the parasitized organs, tissues and cavities of the host which may terminate fatally either in the early or later stages of the life cycle of the parasite, or else these pathological processes may produce a condition of severe emaciation which is accompanied by an anemia in most cases.

The writers' investigations, which have already been partly reported in abstract,[1] have cleared up the cause of a pathological condition of the liver of swine which is responsible for the condemnation of livers in abattoirs, these livers usually having been designated by meat inspectors as "parasitic livers" without adequate evidence, however, as to the parasitic origin of the lesions and as to the kind of parasite involved. The investigations reported in this paper have definitely established the fact that in most, if not all, cases so-called "parasitic livers" contain either active or healed lesions which have been produced by *Stephanurus dentatus,* and have thus cleared up a problem of considerable importance and interest from the view-point of meat inspection.

COURSE OF LIFE CYCLE

1. *Preparasitic stages.*—Under laboratory conditions, at a temperature of about 26° to 27° C. the preparasitic stages of the development of *S. dentatus* were completed in from five to six days. Eggs obtained from gravid females and cultured in water or on a charcoal and feces mixture hatched in from twenty-four to forty-eight hours, and the larvae reached the first lethargus about twenty-four hours after hatching. The second lethargus was reached about forty-eight hours later, and the infective stage, that of the third stage larva, was usually attained about twenty-four hours after the onset of the second lethargus. Low temperatures have been found to retard the development of the eggs and larvae, and at temperatures sufficiently low not only was development arrested but the vitality of the eggs and larvae was destroyed. Thus, at a temperature of about 10° C., the eggs were not only unable to develop, but their vitality was completely destroyed in ten days. At temperatures ranging from 1.5 to −3.8° C. the vitality of eggs was destroyed in about twenty-four hours.

It has been determined that the preinfective larvae are readily destroyed by low temperatures. After having been kept at a temperature of 10° C. for a week, a culture of such larvae was removed to room temperature. Microscopic examination disclosed the fact that the larvae were inactive and had not yet attained the infective stage. Within a short period after the culture was removed from the refrigerator the larvae underwent a granular degeneration. The infective larvae also were found to be deleteriously affected by low temperatures and their vitality was rapidly destroyed by freezing. At a temperature of −19° C. the vitality of the infective larvae was destroyed in nine hours, but after six hours' exposure to this temperature some of the larvae were still viable. When the larvae were air dried on a slide their vitality was destroyed in about thirty minutes, but shorter periods of exposure did not prove fatal to all larvae. A fifteen- to twenty-minute exposure to drying showed many dead larvae; others recovered from such exposure following the addition of a drop of water.

2. *Experiments on skin penetration.*—The infective larvae of *Stephanurus dentatus* were found to be incapable of penetrating the intact skin of pigs. In several experiments infestation did not result following the exposure of the skin of the abdomen and of the inguinal and axillary regions to rich cultures of infective larvae. Under experimental conditions the larvae were found to be incapable of penetrating the skin of a three-day-old mouse stretched tightly across a cork ring, which was floated in a beaker containing physiological salt solution at a temperature of 37.8° C. When larvae were placed on the scarified skin of pigs or when they were injected subcutaneously infection resulted, the course of development being similar to that which followed the administration of larvae by mouth.

[1] *Journal of Parasitology,* vol. 15, No. 2, 1928.

3. *Migrations of larvae in the body of their hosts.*—The path followed by the larvae in the body of pigs, as determined in these investigations, is from the intestine to the liver by way of the portal vein. Some larvae remain in the portal vein and its branches for long periods, whereas others make their way into the hepatic tissue, gradually reaching the capsule. They wander extensively beneath the capsule of the liver, their paths being marked in the form of linear lesions which are visible underneath the capsule. The agamic worms are capable of perforating the liver capsule, thus getting into the abdominal cavity where they wander freely over the surfaces of the viscera. The agamic worms are also capable of perforating the wall of the portal vein and on reaching the perivascular connective tissue they penetrate it and become encapsulated. The larvae also occur in the lungs, reaching this organ by wandering from the liver through the vena cava or through the lymphatic circulation. In experimental infestations larvae and thrombi were almost invariably found in the posterior vena cava of pigs. In experimental infestations of guinea-pigs, larvae were commonly found in the lymph nodes, and in one instance a larva was also found in the blood taken directly from the heart. The agamic worms enter the perirenal fat from the abdominal cavity, boring into it with the aid of the buccal capsule. They also bore into other tissues, notably the wall of the stomach and the duodenum, the spleen, pancreas, lumbar muscles, diaphragm and other organs and tissues with which they come in contact.

In experimental stephanuriasis in pigs, worms appear in the liver and lungs before they are found in the peritoneal cavity and in such organs as the spleen and pancreas. The agamic worms are found entering the perirenal fat relatively late in the course of experimental infestations.

The principal lesions associated with experimental kidney worm infestation of swine are as follows: In heavy experimental infestations pleurisy and peritonitis are present; the abdominal cavity may contain a sero-purulent fluid. The liver is roughened, covered with a fibrinous exudate, and usually adherent to the diaphragm. The spleen is commonly covered with a fibrinous exudate. A fibrinous exudate is also found on the lungs in heavy experimental infestations. The portal vein and its branches, the posterior vena cava and the gastrohepatic artery show numerous thrombi and cicatrices. The periportal connective tissue is greatly increased. The liver, lungs and perirenal fat show abscesses in which the worms are found intact or in which they have degenerated into a creamy mass.

Deaths following experimental infestations of pigs were found to be common, the period of survival of these animals, following the administration of larvae, being dependent to a considerable extent upon the number of larvae administered.

HOST RELATIONSHIP

Although *Stephanurus dentatus* is known to reach sexual maturity in hogs only, the worms are by no means uncommon in cattle. In some of the southern states these parasites are responsible for condemnations of cattle livers. *Stephanurus* has been reared experimentally in guinea-pigs, in which animals they have been found to attain a considerable growth and development.

RELATION OF KIDNEY WORMS TO PARASITIC LIVERS

The liver lesions resulting from experimental stephanuriasis are of special significance in view of their importance from the view-point of meat inspection. In light infestations lesions in organs other than the liver may be slight or absent; the liver, however, shows lesions invariably and the healed lesions stand out as striking abnormalities.

The livers of experimentally infested pigs examined after the agamic worms have left the liver show thickening and scarring of the liver capsule, and a marked increase in the amount of interlobular connective tissue which in some areas has completely replaced the parenchymatous tissue. The surface of the livers also shows slightly elevated grayish mottled areas and occasionally small reddish areas which on section are found to contain blood.

Histological examination of tissue removed from such livers shows a pronounced increase in the interlobular connective tissue and pressure atrophy of the liver lobules which, in some areas, are almost entirely replaced by fibrous connective tissue. There is also a pronounced cellular infiltration, the majority of the cells being eosinophiles.

Livers condemned as "parasitic livers" at various abattoirs and sent to the Bureau of Animal Industry for examination have been compared with livers from cases with lesions experimentally produced by infecting swine with the larvae of *Stephanurus* and in all cases histological examination of such livers has shown the two conditions to be identical.

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TRANSMISSION STUDIES WITH THE NEW PSYLLID-YELLOWS DISEASE OF SOLANACEOUS PLANTS

DURING the years of 1926, 1927 and 1928 a peculiarly destructive disease of potatoes was found on the western slope of Colorado in the potato fields, and it was thought to be associated with the common tomato psyllid (*Paratrioza Cockerelli Sulc.*). The exact nature of the injury is not well understood, and it was thought either to be caused by a toxic material secreted by the nymph while feeding on the leaves of the plants or that the insect transmitted a so-called virus. The disease is apparently different from any of the so far described diseases of either the potato or the tomato. The outstanding characteristic symptom is the upward cupping of the leaves and a marked dwarfing of the plant. The disease was most severe during the 1927 growing season, when the early potato crop was reduced from a six hundred to a two carload crop. Since 1927 it has been found on other solanaceous plants and the most damage has been observed on the potato and tomato crops.

The investigations carried on to date indicate that the injury is not produced by the feeding of the psyllid nymph alone.[1] Eggs laid by viruliferous tomato psyllids on diseased plants, grown under caged conditions, were hatched artificially under sterile conditions. The nymphs so secured were placed on healthy tomato plants and permitted to feed for the first time on the growing portions of the plants. The nymphs were permitted to feed until reaching the adult stage and in each case no injury was observed on the plants. Duplicate checks produced the same effect. The results indicate that the so-called virus is not transmitted through the egg and then to the nymph stage, and further that the feeding of the nymphs alone does not severely injure the growth of the tomato plants.

In the observations made, with viruliferous nymphs under caged conditions, the disease was transmitted from affected to healthy plants in a short time. Viruliferous nymphs were transferred from diseased to healthy potato plants and the characteristic symptoms produced within seven to ten days. The insects apparently bear an important relationship to the disease, and are important in spreading and transmitting the disease. The disease has been transmitted from diseased tomato to healthy potato plants and also from potato to tomato plants. It has also been transmitted to the common garden pepper, to eggplant and to the ornamental Jerusalem cherry. The evidence to date indicates that the disease is of a virus nature.

Artificial inoculation, of extracted and filtered juice secured from a diseased plant, by means of a needle injection, did not prove to be a satisfactory method of transmission.

The scale-like nature of the nymph, its habit of feeding on the under-side of the leaves, and the further protection afforded by the cupping or upward rolling of the leaves make control by spraying and dusting a very difficult problem. The strong spray mixtures necessary to kill the insect injure the foliage of tender solanaceous plants. The destructive nature of the disease and the difficulties encountered in control indicate that it may become one of the most serious diseases affecting solanaceous plants in the inter-mountain region.

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Polarized fluorescence in liquids: ERNEST MERRITT and DONALD ROGER MOREY. While the light emitted by fluorescent liquids ordinarily shows no polarization, it has been found that solutions of fluorescent materials in highly viscous solvents emit light which is partially polarized. In its dependence on the direction of emission and on the state of polarization of the exciting light the fluorescence of such solutions is qualitatively similar to the light scattered by small suspended particles in the Tyndall effect. The polarization is, however, never complete. The polarized fluorescence of viscous solutions, first noticed by Weigert, has been studied by numerous observers, and has been satisfactorily explained as the result of the relatively slow Brownian rotations of the active molecules, for if the viscosity is sufficiently great the excited molecules will return to the normal state before the random distribution has been reached which is necessary for unpolarized emission. The percentage of polarization will therefore depend upon two factors: *viz.*, (1) the extent to which viscosity slows up the Brownian movements of rotation, and (2) the duration of the excited state. Since the fluorescence spectrum consists of a band extending over a range of several hundred Ångström units, it seems not unlikely that the duration of the excited state is different for the excited molecules corresponding to different parts of the band. And in this case we should expect the amount of polarization to vary, probably progressively, throughout the spectrum. Unfortunately, the only two attempts that have previously been made to determine a possible variation of polarization with wave-length have led to contradictory results. The question seems therefore to call for further experiment. Using glycerin solutions of rhodamin B and of uranin we have compared the intensity of the fluorescent light

[1] The psyllids used in the cage experiments were kindly identified by E. O. Essig, entomologist of the University of California.

for the directions of maximum and minimum polarization by a photographic method. A rectangular cell containing the fluorescent solution was placed in front of each of the two slits of a Lummer-Brodhun spectrophotometer and the two solutions were simultaneously excited by light from a mercury arc. With nicol prisms to secure proper conditions of polarization and color filters to prevent errors due to stray light the two spectra formed were photographed one above the other on the same plate and the intensities were adjusted by trial until the two were as nearly as possible alike. The density of the image on the plate was measured by a microphotometer. The measurements made thus far indicate that the polarization of the fluorescent light for the two substances tested is constant throughout the fluorescence band. In the case of uranin, however, the spectrum appears to consist of two overlapping bands, and in one of these the polarization is considerably greater than in the other. The results thus add support to the view that the processes involved in the emission of the different parts of a fluorescence band are so closely connected that each band is to be regarded as a unit.

The relative intensity of X-ray satellites: F. K. RICHTMYER and L. S. TAYLOR. Close to and on the short wavelength side of many of the more prominent X-ray spectrum lines are faint lines called satellites. Two theories of their origin have been proposed: (1) A single-electron jump between doubly ionized states of the atom; and (2) a simultaneous two-electron jump between doubly ionized states, the resulting energy thus freed being emitted as a single quantum of slightly higher frequency than that of the parent line. The first theory requires double ionization of inner electron shells. The second requires single ionization of one inner and one outer shell. Data concerning the relative intensities of satellites compared to parent lines should be of value in deciding between these two theories. No quantitative measurements of such intensities have been previously made. Using the double X-ray spectrometer and accessory equipment of Professor Bergen Davis at Columbia University, the authors have measured the intensity of the satellite $Ka_{3,4}$ of the "parent" line $Ka_{1,2}$ of Cu (29), and of Ni (28). The following are the important results: (1) The wavelengths of the satellites determined by this ionization method agree well with other determinations by the photographic method. (2) In the photographic method the satellites were unresolved. They are clearly resolved by the double X-ray spectrometer into two, or possibly three, components. (3) The intensity of $Ka_{3,4}$ for Cu is about 0.00400 of the intensity of $Ka_{1,2}$. From (3) one concludes that the number of atoms, doubly ionized in such a manner as to produce $Ka_{3,4}$, is about 1/250 of the number of singly ionized atoms under the conditions of the experiment. It is hoped to continue this investigation to ascertain how this ratio varies with applied voltage and with atomic number of the target.

The Waidner-Burgess standard of light: H. T. WENSEL, M. F. ROESER, L. E. BARBROW and F. R. CALDWELL (introduced by G. K. Burgess). Following out the suggestion made in 1908 by Waidner and Burgess, the luminous intensity of the primary photometric standards of the Bureau of Standards has been compared with the brightness of a black body at the freezing-point of platinum. The black body standard was realized experimentally by immersing a tube of fused thoria in a bath of purest platinum (purity higher than .999996) contained in a crucible of fused thoria. The platinum was melted in a high frequency induction furnace and observations of brightness were taken during the period of freezing. The brightness of the Waidner-Burgess Standard was found to be 58.9 International Candles per sq. cm.

Preparation and resolution of 2,2′ difluors. 6,6′ dicarboxyl diphenyl: ROGER ADAMS.

On the technique of measuring the magnetic susceptibility of gases: FRANCIS BITTER (introduced by R. A. Millikan). At the present time accurate methods for measuring the magnetic susceptibility of gases are of considerable importance for the solution of two problems: the origin of the anomaly in the pressure dependence observed by A. Glaser (*Ann. der Physik,* 2: 233, 1929); and the establishment of an upper limit for, and perhaps the measurement of, nuclear magnetic moments by accurate measurements of the temperature dependence of the magnetic susceptibilities of gases like hydrogen, nitrogen, xenon, etc. A new type of suspension for a Glaser-type apparatus consisting essentially of a closed glass cylinder divided radially into four equal chambers is discussed. The zero reading is practically independent of the field strength and the temperature, and in consequence two of the most important possible sources of error in previous measurements are removed. The method is discussed as to the limits of its sensitivity and applicability.

On the magnetic properties of electrons in metals: FRANCIS BITTER (introduced by R. A. Millikan). In order to calculate the diamagnetic contribution of free electrons to the magnetic susceptibility of a metal, two expressions are necessary: firstly the magnetic moment of a free electron as a function of its energy, and secondly the distribution of the energy among all the electrons. The application of the Fermi statistics to a gas of free electrons performing elastic collisions with the atoms of the lattice leads to an expression for the susceptibility which can not be reconciled with the facts. It is shown that the discrepancy is due to improper assumptions concerning the interaction of the electrons with the lattice in the metal. The magnetic perturbation of a free electron in a lattice is discussed according to wave-mechanical methods. This gives for elements in the first column of the periodic table a diamagnetism less than the paramagnetism due to free electrons as calculated by Pauli.

The magnetic properties and microstructure of some high platinum alloys: F. WOODBRIDGE CONSTANT (introduced by R. A. Millikan). In view of the present unsatisfactory state of our knowledge concerning the mechanism of ferromagnetism, a study of the Pt-Co series of alloys is interesting. These alloys are ferromagnetic even

for high platinum concentrations, as recently reported by the author (*Phys. Rev.*, October 15, 1929); the magnetic moment per cobalt atom actually increased with platinum concentration. The phase diagram for these alloys not being known, an investigation of the microstructure was made microscopically which showed them to be solid solutions. Under high magnifications, the individual crystals showed the mosaic structure predicted by Zwicky. Since the cobalt atoms may be regarded as further isolated from one another by the presence of the platinum, their magnetic properties are discussed with reference to the recent theories of ferromagnetism.

Theory of deflection of neutral molecules in non-homogeneous electric fields, with and without a crossed uniform magnetic field: H. P. ROBERTSON and E. A. MACMILLAN (introduced by K. T. Compton).

The quantum mechanical theory of electron scattering from crystals: PHILIP M. MORSE (introduced by K. T. Compton). A detailed analysis of the behavior of an electron stream impinging on a crystal lattice shows that the rules for the scattered beams, obtained by considering the electron as completely analogous to a beam of X-rays, are only approximately correct. For instance, for normal incidence, it is shown that the electronic energy E for intense specular reflection would be $(n^2h^2/8md_x^2) - V_o + G_n$, where n is an integer, m the mass of the electron, d_x the separation between the atom planes parallel to the surface, V_o the work function of the crystal and G_n a small correction which varies with changed surface conditions and with change of n. The result obtained by analogy with X-rays would not include G_n. The known experimental evidence confirms the necessity of including G_n. The "index of refraction" of the electron beam is shown to be $\sqrt{(E+V_o+f)/E}$, whereas the analogy with X-rays would make it $\sqrt{(E+V_o)/E}$. The function f is very small except when $E \sin^2\theta = n^2h^2/8md_y^2$, where θ is the angle of incidence and d_y is the separation between the atom planes perpendicular to the plane of incidence. At these particular values of $E \sin^2\theta$, the rapid variation of f produces a change in the index of refraction similar to anomalous dispersion. Experiments have found such cases of "anomalous dispersion" at values of $E \sin^2\theta$ which check with the theory. Thus the quantum mechanical theory of the electron explains not only the general effect of scattering from crystals, but also the small peculiarities in the experimental results. This work was done at the Bell Telephone Laboratories under the supervision of Dr. C. J. Davisson, to whom the writer is greatly indebted.

Series in the copper arc spectrum: A. G. SHENSTONE (introduced by K. T. Compton).

Comparison of protons and electrons in the excitation of X-rays by impact: HENRY A. BARTON (introduced by Ernest Merritt). The fundamental charged particles in nature are the electron and the proton. The great difference in behavior of the two in collisions with atoms probably arises chiefly from the fact that the proton is 1,846 times as massive as the electron. The new wave mechanics presents the possibility, not yet quite realized, of quantitatively comparing the effectiveness of the two particles in collision processes. An example is the efficiency in the production of X-radiation by bombardment of a target. So far, the wave mechanics only states that the critical energy for the production of the characteristic radiation (*e.g.*, Cu-K) shall be the same whether protons or electrons are used as the striking particles. No formula for the intensity has yet been derived. The work to be described aims to furnish a basis of experimental fact with which eventually to check the theory. An arrangement resembling a mass spectrograph was used to bring either a beam of electrons or of protons onto a copper target. The design of the apparatus was such that several possible sources of erroneous conclusions were eliminated. The comparison between radiation produced by proton, as opposed to electron, impact could be made with identical energies, target, detecting device and geometrical arrangement. It was found that with the proton currents that could be produced, the X-radiation excited was too weak to detect, the experiment thus yielding a negative result. However, a calibration of the overall sensitivity of the apparatus for an electron beam enabled the setting of a certain upper limit to the effectiveness of protons. The direct experimental conclusion reached is that ρ, the ratio of the excitation efficiency of electrons to that of protons, is of the order of 10^5 or greater. This number is well above the ratio (M/m), about the same as $(M/m)^{3/2} = 79{,}310$ and considerably smaller than $(M/m)^2$.

Positive ion emission from tungsten and molybdenum: L. P. SMITH (introduced by Ernest Merritt). An examination of the positive ion emission from tungsten and molybdenum has been made in which it was sought to determine the following points: (1) The nature of the ions emitted at various temperatures; (2) the temperature variation of the positive ion current; (3) the theory of positive ion emission with regard to where and how the ions are formed; (4) the positive ion work function for these metals; (5) to determine whether the work function, determined by experiment, checks with that calculated by a simple cyclic process involving the thermionic work function, the ionizing potential and the latent heat of evaporization of the metal. The mass spectrum for tungsten and molybdenum filaments taken at moderate temperatures (1700° to 2000°) has shown that the emitted ions consist of sodium, the two isotopes of potassium and aluminum. At high temperatures these impurities disappear and finally both tungsten and molybdenum filaments yield positive ions of their own metal. The latter confirm a report by Wahlin (*Phys. Rev.*, 34: 164, 1929). The temperature variation of the positive ion current at high temperature yields a value of 6.55 volts for the positive ion work function of tungsten and 6.09 volts for that of molybdenum. These values disagree widely from the values 10.88 volts and 9.26 volts calculated from the simple cyclic process mentioned above. This suggests that the ions are formed as a by-product of

an irreversible recrystallization of the metal. Theoretical considerations show that the ions are emitted from the metal and are not formed after a neutral atom evaporates.

On shatter-oscillations in liquid columns: E. H. Kennard (introduced by Ernest Merritt). In some experiments recently witnessed by the writer in an industrial plant an extraordinary and apparently little-known type of fluid oscillation was observed. A pipe thirty-one meters long, filled with water, was connected to a tank containing some water and above it air under a pressure of three to four atmospheres; to the other end of the pipe was attached a pump. A recording gauge attached to the pipe near the pump showed at regular intervals narrow peaks of pressure, ranging as high as seventy atmospheres, separated by calm intervals four to eleven times as long as the duration of the peaks, during which the pressure appeared to be slightly below atmospheric. The interval between the peaks was several times longer than the period of oscillation of the water column regarded as a closed organ pipe. The proposed explanation is that when the water column expands and its pressure sinks to zero, the column "shatters." Theory indicates that, as soon as the pressure reaches zero at one point, a shatter-front will sweep from that point in both directions along the column with a speed above that of sound, leaving the water in an expanding condition behind it; no large breaks in the column can occur, but it will become full of little cracks or holes. During the subsequent reconsolidation of the column the water may acquire high velocities toward the pump, and when the reconsolidation-front reaches the pump an impulsive "water-hammer" pressure will result. A detailed study of such oscillations in the laboratory would be of interest.

On the existence of integrals of Einstein's gravitational equations for free space and their extension to a variable: T. Y. Thomas (introduced by O. Veblen).

Memoir of John Trowbridge: E. H. Hall.

Biographical memoir of John Merle Coulter: William Trelease.

Two contradictions in current physical theory and their resolution: F. S. C. Northrop. Our purpose is to show that two contradictions exist in current physical theory which can be met only by a certain amendment to our traditional atomic theory. The first contradiction will be demonstrated by establishing three propositions. (1) Atomicity is an inescapable fact. (2) Atomicity necessitates the existence of a referent other than the microscopic particles. (3) According to current scientific theory no such referent exists. It appears that the facts permit no conclusion but that a new referent must be introduced into our traditional atomic theory to replace the discarded absolute space. The second contradiction also rests on three propositions. (1) The metric of space is conditioned by matter. (2) This metrical structure exhibits uniformity over macroscopic distances. (3) Matter, as currently conceived, is incapable of producing such uniformity. Since neither of the first two premises can be escaped it follows that our traditional theory of matter must be amended to provide a basis for the metrical uniformity which was previously assigned to absolute space. A consideration of what is required to produce the type of metric, which Einstein suggests and the facts reveal, indicates what the required amendment must be. In a relativity theory, space is a relation between objects. Hence metrical variability means that the relations between the ultimate atomic entities change; and metrical uniformity means that they do not. It becomes evident, therefore, that the kinetic and contingent properties of the microscopic elements of the traditional atomic theory insure their adequacy as the source of local metrical variability, but eliminate them as the source of macroscopic metrical uniformity. In short, the general macroscopic uniformity must be regarded as imposed upon their contingent relatedness from without. This calls for an entity which is atomic and physical in character, and so large in size and fixed in form as to surround and congest all the microscopic atomic entities of the traditional atomic theory.

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Clark, W., T. Slater Price and B. V. Storr, Editors. *Proceedings of the Seventh International Congress of Photography.* Pp. xiii + 571. Illustrated. Heffer. 25s.

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SCIENCE NEWS

Science Service, Washington, D. C.

MEASUREMENTS OF THE VELOCITY OF LIGHT

REFLECTING a beam of light back and forth on a ten-mile journey through a mile of iron pipe from which the air has been exhausted, in order to measure light's speed, from preliminary experiments just completed at the Mount Wilson Observatory, seems to be feasible. The method was proposed by Dr. A. A. Michelson, who will go to Pasadena next spring for the final experiment.

Previous measurements by Dr. Michelson of the speed of light were made near Pasadena by reflecting the light to a distant mountain peak and back, but uncertainties were introduced by the lack of knowledge of the condition of the air over the entire path. By using an evacuated pipe for the light path this difficulty is overcome.

In order to see whether a satisfactory image could be obtained, 1,100 feet of the pipe were laid, and preliminary tests made by F. G. Pease and E. C. Nichols, both of the observatory staff. The light came from a narrow slit, and was made into a parallel beam by a concave mirror. Thence the light passed to the other end of the pipe, where a flat mirror reflected it back. At the first end another flat mirror sent the light down the pipe again, and so it went back and forth, traveling all told about a mile. Finally, it reached a second concave mirror, which was intended to form an image of the slit.

When the pipe contained air at the same pressure as in the atmosphere, no image could be obtained. But when the air pumps were started and the air exhausted to about one eighth of normal pressure, an image appeared. When a vacuum of about a thirtieth of ordinary pressure, or half a pound to the square inch, was reached, a clear and sharp image of the slit was seen. This shows that the method is practicable, and the rest of the mile of pipe, which is made of corrugated iron, with soldered joints, will be laid.

Professor Michelson is now convalescing from an attack of pneumonia, and expects to go to Jamaica for a few months. He plans to go to Pasadena on about May 1, when the pipe will be finished, and the final experiment can then be carried out.

INFRA-RED PHOTOGRAPHS

BECAUSE movie producers wanted a film that would give night effects to pictures taken in the daytime, Mount Wilson Observatory astronomers have been able to prove conclusively the presence in the sun of carbon, most typical element of all living things, by spectrum photographs in infra-red light.

Speaking at the Carnegie Institution of Washington, Harold D. Babcock, of the Mount Wilson Observatory, told of this and other phases of his researches into methods of taking photographs with light vibrating too slowly to be seen. This is called the infra-red region of the spectrum.

When the white light of sunshine is broken up by the prisms of a spectroscope, it is spread out into the familiar colored spectrum, ranging from the shortest and most rapidly vibrating rays that make violet light to the longer and more slowly vibrating red rays. Though not visible to the eye, the spectrum extends far beyond each end. Ordinary photographic plates record the ultra-violet or the region beyond the violet end, but are insensitive to even the visible red. Panchromatic plates are sensitive to red light, but not to a great deal of the infra-red, the still longer waves. These are the heat waves, and so it has been possible to study them by temperature effects. At best, however, this method is not as good as direct photography, and physicists and astronomers have sought a way of photographing these long waves. Many years ago Sir William Abney, an English experimenter, succeeded in photographing by very long infra-red rays, but his method was difficult and uncertain, and has not been used since.

The movie produces sought a way of photographing night scenes in the daytime, so as to avoid the use of powerful and expensive lights required for night photography out of doors. Photographs made by infra-red light give a black sky, and so they sought film to take movies by the infra-red part of sunlight. To meet this commercial need, explained Mr. Babcock, research chemists at the laboratories of the Eastman Kodak Company produced a new dye, neocyanin. Film or plates bathed in a solution of this dye acquire sensitivity to infra-red light, and the demands of the movies were satisfied.

Mr. Babcock also showed a photograph taken by these same plates in absolute darkness, to the eye. Using three bowl-type electric heaters, supplied with just enough current to heat their coils, without giving any visible red light whatever, he photographed some bottles and laboratory apparatus by infra-red light. An exposure of 48 hours was required.

"The significance of lines in the spectrum lies in the fact that they announce the occurrence of definite changes of atomic energy," said Mr. Babcock. "The arrangement of lines in the spectra of the elements leads to a knowledge of the arrangement of the outer electrons of the atoms, of fundamental importance to the understanding of their physical and chemical relationships."

With the new plates, it is possible to extend this study far into the invisible infra-red part of the spectrum. Mr. Babcock has made photographs of the solar spectrum by light waves nearly half again as long as the longest visible red waves. These waves are about twice as long as those of green light, and lie about twice as far beyond the end of the visible spectrum as those photographed by Sir William Abney.

One of the first results of this new method has been the definite proof of the presence of carbon in the sun. Previously only a few weak lines of this element have been photographed, but with the new plates one of the

principal groups of the lines of carbon can be recorded. These are in the same position as carbon lines from a terrestrial source, and show conclusively that the sun, like our own bodies, contains carbon.

ACORN-STORING WOODPECKERS

THE acorn-storing woodpecker of California has become one of the most successful of birds because it uses its head. It uses its head not merely figuratively, in intelligent adaptation to the advantages and disadvantages of its environment, but also literally, in that its head is its chief physical means of making such adaptation.

These are the conclusions reached by Dr. William E. Ritter, emeritus professor of zoology at the University of California, after several years of critical study of the California woodpecker in its native haunts, which will be described in the forthcoming issue of the *Quarterly Review of Biology*.

Unlike almost all other American woodpeckers, the California species has taken to a vegetable diet, consisting mostly of the acorns of two species of oaks. Examinations of the stomachs of numerous woodpecker specimens have shown, in most cases, little more than a trace of the insects that form the bulk of the food of most woodpeckers; and these are mostly insects caught in the open on the wing, instead of being laboriously drilled out of tree trunks.

The California woodpecker does bore holes in trees, but only for the purpose of putting acorns into them. California trees and telephone poles are frequently fairly peppered with acorn-filled holes, as though some one had been driving round-headed nails into them.

Dr. Ritter finds that the woodpecker makes good use of his head in four ways: in boring holes to fit his acorns according to their size, in selecting acorns of a size he can best handle, in choosing places where he can store his acorns with the best economy of labor and in splitting some of his acorns in half, thereby making their handling easier. The bird prefers acorns from two species of oak, black oak and live-oak, which are of a shape convenient for him to handle, but he passes up the acorns of the valley oak, which are too big. Yet he will take live-oak acorns to valley oaks to store them, because it is easier for him to drill storage holes in this tree, or to wedge his acorns into the ridges of its bark.

However, the California woodpecker is no paragon of wisdom, Dr. Ritter has found. He is as big a fool as the rest of us, on occasion. Sometimes he will, in an excess of storing zeal, drill holes and fill them with completely useless objects, such as pebbles, or hard-shelled nuts that he will never be able to open. He will also drill holes through the side of a house, and then stuff quarts of acorns into this (for him) bottomless pit whence they can never be recovered—just like an amateur speculator dumping his money into a bucket-shop! Or he will work hard on holes that might be filled with acorns, and then go gadding off on some pointless errand and forget to come back and fill them.

Yet in spite of his occasional flights of folly, the California woodpecker has a decided balance of sense in his favor, if his success in filling the oak woods of his native state with his own species can be taken as any criterion. By adopting the fruit of a wide-spread tree as his principal food, and by learning how to lay by a stock of it in secure storage places, he has been able to increase and multiply until he outnumbers his nearest competitor in the woodpecker family of the same geographical range in a ratio of about five to one.

CARE OF THE GREAT ELK HERD

EXTENSION of their winter range, eliminating as much as possible the crowding and concentration incident to feeding with hay, is one of the keys to the promotion of good health in the great elk herd of Jackson Hole, south of Yellowstone National Park. This was brought out at a meeting of the Commission on the Conservation of the Jackson Hole Elk, by O. J. Murie, of the U. S. Biological Survey, who has spent something over two years following the herd and learning their ways and life problems. The commission consists of representatives of U. S. Government departments, the state of Wyoming, various wild life organizations and business men of the region.

It is necessary to feed hay to the elk comparatively early in the winter under present conditions, Mr. Murie explained, because if this it not done the animals crowd upon the ranches in the valley, stealing hay intended for the farmers' livestock and in general raising a disturbance. This prolongs the period of their crowding together on the elk feeding grounds, and crowded elk interchange disease germs just as crowded human beings do. If some or all of the ranch lands can be acquired and turned into elk range, the elk can be left to shift for themselves farther into the winter, keeping them uncrowded and in better condition than they are at present.

The most prevalent of the serious diseases among the elk, Mr. Murie stated, is necrotic stomatitis, known to cattlemen as "soremouth." Its symptoms are severe inflammation and lesions, finally causing eating away of the bone. It also evidences itself in other parts of the body through pneumonia, pleurisy, arthritis and a condition like diphtheria, resulting in death through strangulation and general poisoning.

The mode of entry of the disease is not definitely known as yet, but suspicion attaches to the long, sharp bristles of fox-tail grass, which is very common on the valley ranch lands. This makes punctures in the mouth lining of the elk, and may thus initiate the infection.

The chief sufferers are the calves and the adult cows. Both of these groups lose as many as 18 per cent. of their numbers in an ordinarily severe winter, whereas the average loss for the herd as a whole is less than 6 per cent.

The conversion of practically all the Jackson Hole area into a game range is not unattended by difficulties. All the various interests involved wish to see the elk herd prosper, and are willing to cooperate toward that end. There are, however, several problems in land economics that have to be met in the acquisition of the ranch lands and their restoration to public ownership, and it is toward the solution of these that the efforts of the commission are now being directed.

ANTHROPOLOGICAL EXPEDITION TO AUSTRALIA

NATIVES of Australia who still live as prehistoric men of the Old Stone Age will be sought out for study by an expedition from the University of Pennsylvania Museum, it is announced. Dr. D. S. Davidson, who will lead the expedition, will leave for Australia this month to spend two or more years there.

"The Australian tribes have many physical features similar to those of the Neanderthal race which inhabited Europe about 50,000 years ago, and it would seem that they have not advanced from that time to this," according to Dr. Davidson.

The Australian aborigines have no clothing, even in regions where the climate is far from tropical, he explained. They have no domestic animals, and raise no crops, but eat chiefly game and wild fruits and vegetables. They live in temporary huts which offer little protection from rain or cold, and have no knowledge of pottery or basket-making. Clubs and spears are their only weapons.

The fact that the Australian tribes do not use the bow and arrow, which is one of the most important inventions of early man, would seem to indicate that they must have emigrated from the mainland of Asia before the bow and arrow was known, hence in very remote antiquity.

One puzzle which anthropologists have not solved is why a people with such primitive economic standards should have an extraordinarily complex social system. The regulations and procedures governing ceremonies, marriages and social groupings are perhaps the most involved of any living race.

The Australian tribes are fast disappearing. Dr. Davidson will not only gather as much information as possible about the remaining groups, but he will also seek traces of tribes which once occupied Australia and have become entirely extinct.

ITEMS

PARA rubber trees planted by the Department of Agriculture in Florida are making encouraging progress, according to a report recently given to the Appropriations Committee of the House by Dr. Karl F. Kellerman, associate chief of the Bureau of Plant Industry. The oldest trees in the experiment are four years old. The department has discovered that young rubber trees in such a climate as Florida's must be protected by lattice work. The trees will grow about as well as they do in Haiti, Dr. Kellerman believes. The growth in Haiti is satisfactory, inasmuch as the trees produce as much rubber as they do when grown in the tropics, though they do not seem to be quite so vigorous. A new type of rubber plant from Madagascar is being grown in the department greenhouses and in the Southwest, Dr. Kellerman says. This rubber is known as *Euphorbia intisy*. Growing in its wild state, it formerly produced a superior rubber of the Para type, for which purchasers would pay three or four times as much as they would give for any other rubber.

BY his fruitfulness and cunning the wild boar of Europe, traditional pièce de résistance at Christmas feasts, is managing to hold his own in spite of the lack of protective game laws of any kind. In eastern Germany, particularly in Brandenburg and Pomerania, the land owners appreciate the value of the boar to the forests and see that it is not hunted down too closely. Eighty-five per cent. of injurious forest insects and small animals are estimated to have been destroyed by the boar. In west and south Germany, however, the asset of the boar to forest lands is not so well understood, upwards of 12,000 boars having been killed in Germany in 1925.

TRAVELERS to the south of England for winter holidays may now count on the benefits of the vacation beginning almost the moment they board the train. For its Cornish Riviera express service, an enterprising railway has fitted all its cars with window glass permeable to ultra-violet light. In this way passengers are assured the full value of the sunlight as they travel. The Cornish Riviera is so called because Cornwall, in the extreme south of England, has pleasant, mild winters with more than the average amount of sunlight. It is a favorite winter resort where inhabitants of fog-ridden, smoky cities go for intensive doses of sunlight and health-giving ultra-violet rays.

ONE of the moulds (a Penicillium) has been found to kill cultures of some bacteria, notably pus-forming cocci and diphtheria bacilli. This interesting news comes from Dr. Alexander Fleming, of the laboratory of the inoculation department, St. Mary's Hospital, London. The mould is similar to the common fungus that sometimes spoils oranges and other fruits. Even when cultures are filtered, the resultant liquid which is called "penicillin" is effective. It can be kept for some time if it is neutralized, but, if not, it loses its power after from 10 to 14 days at room temperature. It does not affect all bacteria; for instance, the typhoid group is resistant to its action; on the other hand, staphylococci, streptococci and diphtheria bacteria are killed rapidly. Penicillin is not toxic to animals even when given in large doses, and it is also non-irritant. It is therefore possible that it may turn out to be a useful antiseptic for combating infections caused by certain pathogenic bacteria.

How one of the large Hollywood motion picture laboratories has turned its tanks of old developing solutions into a silver mine yielding $6,000 a month is told by the Bureau of Standards. The emulsion on undeveloped film consists largely of silver, associated with bromine to form silver bromide. When developed, the silver bromide that has been exposed to light changes to metallic silver. In the fixing bath, the unchanged silver bromide is dissolved out, leaving clear spaces where the film was in darkness. Every pound of silver bromide contains over nine ounces of silver. Though miles of film are run through the solutions weekly, and they contain large quantities of silver, they were formerly thrown into the sewer when their power was exhausted. Now, by a simple chemical process, the silver is recovered, and sold to the U. S. Mint at San Francisco. Old film is also burned to recover the silver, and sometimes yields as much as $1,000 worth of silver a month in addition.